SCIENTIFIC AMERICAN SUPPLEMENT. No 1013

Scientific American Supplement, Vol. XXXIX. No. 1013. Scientific American, established 1845.

NEW YORK, JUNE 1, 1895.

Scientific American Supplement, $5 a year. Scientific American and Supplement, $7 a year.

PUTTING THE SPLINTS IN THE PRESS.

PUTTING THE SPLINTS IN THE FORM.

DIPPING THE SPLINTS.

MANUFACTURE OF MATCHES IN FRANCE.

THE MANUFACTURE OF MATCHES.

THE strike, which was thought to be over, has begun again among the workmen employed in the manufacture of matches, which, as well known, is controlled by the government. The claims made by the six hundred and eighty-five strikers of Pantin-Aubervilliers involved, and still involve, three points, viz., the suppression of white phosphorus, the question of pensions, and the use of French wood, which for some time past has been substituted for the more easily worked Riga wood.

No occasion could be better chosen than the present to tell our readers something about this important manufacture, which, moreover, interests every one, since it gives all of us the benefit of a progress that the preceding generation vainly endeavored to realize. It is not necessary to have been a contemporary of Mr. Chateaubriand, who is still a sub lieutenant in the regiment of Navarre, to have known those little rolls of paper called "spills;" and it is not sixty years since, in Lower Brittany and the Bourbonnais, it was necessary to make the rounds of a dozen houses in order to find a bright fire except at meal times. It was then necessary to have recourse to those tinder boxes that now appear to us prehistoric monstrosities when we compare them with Swedish and wax matches, which are clean, harmless and infallible, or which at least ought to be so. It took a long time to exhaust the series of devices for obtaining fire. The use of them is twenty times secular: from the spark-emitting flint, whose adaptations were varied to infinity, one passed to the fire syringe, to the hydro-electric briquet, etc., and finally to the phosphorus box, a very near relative of the match that we now use.

The first manufactory of chemical matches with a phosphorus basis was established in Austria in 1833. These matches were so inflammable that the jolting of the vehicles in which they were carried caused them to "go off." So in most of the German states the use of them was forbidden up to 1840, the epoch at which Preshel invented his famous paste composed of thick gum, chlorate of potash, phosphorus and Prussian blue. Later on, this chemist replaced the chlorate of potash with peroxide of lead, which does not explode.

EMPTYING THE FRAMES.

The popularization of chemical matches was the revolution of lighting, and it was dating from such pacific revolution that the good people were enabled to obtain fire when it pleased them to use it. Flint, German tinder, tinder boxes, etc., departed into the domain of the past as soon as the little splint of luminous wood, which is now the indispensable companion of civilized man, made its appearance.

Before being delivered to consumption, a common match such as we find in every kitchen has to undergo ten operations.

The splints are manufactured at Voiron, Dijon and Angers, and especially in Russia. The output of the cutting machines is about 300,000 splints an hour. The wood usually employed is fir and poplar. The Russians use aspen, and send it to us already prepared in large quantities. In works such as those of Pantin it requires about twenty-four million splints for the daily manufacture. These arrive in huge cases and are almost immediately worked up. To this effect, they are arranged very equally, without overlapping, in a square form called a "batteau." These forms thus filled are placed vertically upon a machine designed to classify and to isolate the splints, in an iron frame quite similar to the frames used by printers. Each row is separated by a felted strip of wood. All the matches are therefore independent and aligned and present their as yet immaculate heads in front of the frame. This assemblage is called the "press," and there are about 7,000 splints to the press. A cap completes the frame and produces the compression.

A small railway with cars, turntables, and branches, carries the presses to the room where the dipping is to be effected. This sad abode would merit a description by Dante. An obnoxious vapor of sulphur and garlicky phosphorus seizes one in the throat and chokes one to such a point that he asks himself whether the unfortunates who are bustling about and working in this fearful place are living beings or spirits. They do not seem to give themselves any concern about it. In one corner, at a square vat filled with molten sulphur, stands a workman holding a press in his hands. He dips the heads in the sulphur with three or four jerky motions, and then deposits his press and takes the following one from the heated table upon which the splints are drying. At the other end of the room, upon plates of metal whose square coincides with that of the presses, two workmen have spread phosphorus paste, which they render very uniform by means of a regulator called a "guide." They seize the sulphured presses in succession and lay them upon the paste. Each splint is thus tipped with a small red capsule and then takes the name of "match." The presses are carried to the drier, where the sulphur and phosphorus acquire the consistency that is well known to us.

SULPHURING THE SPLINTS.

Immediately following the dipping room is that in which the matches are taken out of the presses. This again is a somewhat infernal place, but the pretty-faced and for the most part graceful girls moving about therein agreeably modify the first impression of the visitor. To place the presses in a machine, to press upon a pedal that actuates the latter, to remove the filter strips by a rapid motion of the forefingers, and put the matches in new forms with the heads all pointing in the same direction, such is the work of these operatives. The skillful operative can empty more than one hundred and fifty presses a day. The matches that fall upon the floor during the operation are collected just as they lie, and, through a rapid operation of sorting, resume their regular order.

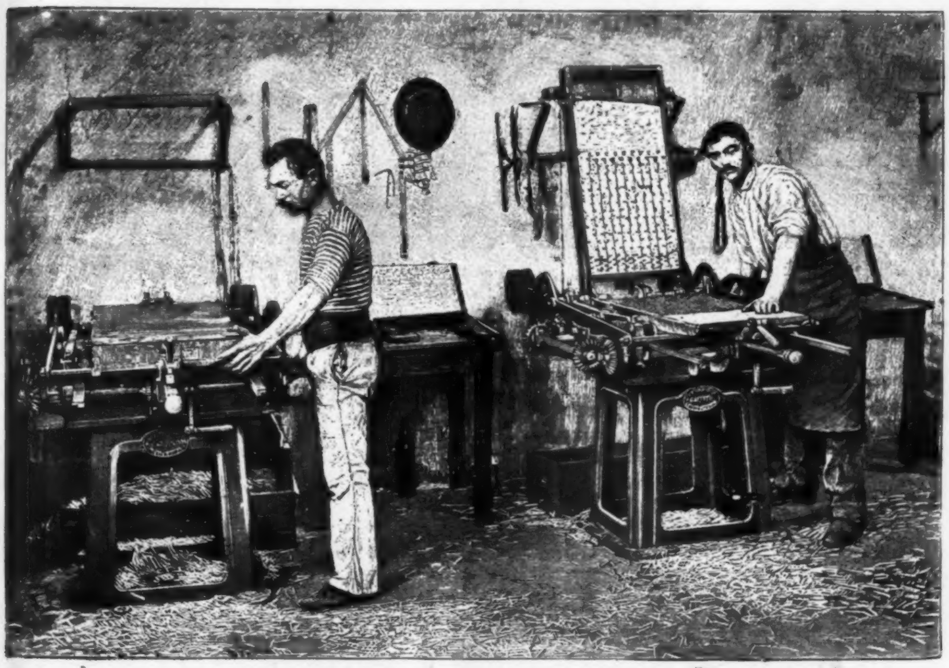
In summer, some of the matches occasionally take fire; but this does not go far. In these eminently combustible surroundings, the intelligently taken precau-

MECHANICAL BOXING.

tions render accidents very rare. Insurance premiums are, nevertheless, high for match manufactories.

The boxing is done in two ways, by machine and by hand. In the machine, the form, covered with glass to allow the operative to watch the motion, is always placed vertically. The matches slide down by their own weight and present themselves before a conduit of a determinate caliber, and which will hold, for example, a hundred matches. An automatic device sends exactly this number into the cardboard box held by the operative at the orifice of the conduit. This operation is performed with amazing rapidity. There are three operatives to each machine. The first fills the boxes and the two others close them. These three operatives prepare twenty thousand boxes in eleven hours of work. They earn, on an average, seventy cents.

PACKING AND STAMPING.



REMOVING INEXTINGUISHABLE MATCHES FROM THE FRAMES.

BOXING.

Farther along are the stampers. To the deafening noise of the machines, to the lethiferous odor of the chemical products, succeed here a semi-silence and respirable atmosphere. One might believe himself to be in a class room of high-toned young ladies. A respectable lady, seated upon a sort of rostrum, exercises surveillance over all these blue aprons, over all these blond or brown heads, and over all these eyes, whose gaze seems to interrogate the mysterious horizon.

These stampers place upon the boxes the vignette of the indirect taxes. A pot of paste, a little skill and much patience is their outfit. A low sound of voices mingled with the rumpling of paper charms the ear, like the noise of wings amid leaves. This relative paradise almost touches the pestiferous laboratory.

The administration, however, takes a few paternal measures against the poisoning of its people. Unfortunately, the workmen seem to systematically repel the preservatives put at their disposal. Thus, gargling with chlorate of potash, which should be done before leaving the factory, is neglected.

It is a curious thing that it is the women especially who avoid it. The thought of the horrible phosphorus necrosis, which causes suffering and which disintegrates the living bones as if they had passed fifty winters in a damp coffin, drives them away from the counterpoison, while, on the contrary, it ought to attract them to it. Alas! they do not even wish to take a glimpse at the desolating perspective offered them by the future. What misery! What fatality! What excuse?

After thirty years of faithful service—mark you, thirty years—the generous state grants its match makers a pension that never exceeds $120 for men and $80 for women! It is just to add that it pays the surgeon when the latter with mallet and gouge sculptures a skull or extirpates a putrified maxillary bone.

Are the cases rare? it is asked. They can hardly be called so, answers authoritatively Dr. Magitot, a specialist well known for his interesting work on the "Chemical Disease." Moreover, ought it not suffice to have a single case of this hideous affection occur in order to cause one to seek, reseek and finally find a means of remedying it?

In reality, such a means does exist. Do away with white phosphorus, say the philanthropists, and you will do away with necrosis. Causa ablata, tollitur effectus! Very well; but the administration answers:

"Gentlemen, trade before philanthropy. White phosphorus does not cost so much as amorphous phosphorus and the salts of potassa. We are obliged to continue the use of white phosphorus."

The manufacture of Swedish matches differs but little from that of the common ones, especially as regards the cutting, the arrangement of the splints and the dipping. Yet, what is an immense advantage, they are treated with neither sulphur nor phosphorus, but are prepared with a paste of chlorate of potash, which ignites only upon the preparation spread upon two of the sides of the box by a very simple and ingenious machine. This machine consists of a conduit of the exact width of the boxes and of two rollers charged with the scratch paste. In measure as the boxes defile between these rollers, they are uniformly covered upon the two sides at once. The base of the scratch paste is sulphide of antimony and red phosphorus.

The Pantin works also manufacture inextinguishable matches, which brave the fury of the tempest and the anger of Æolus. These matches are elegant and useful. The splints are dyed of a superb ultramarine blue. The coloring is done by immersing them for a few minutes in a kettle of boiling water deeply colored with blue in powder. In the place where this picturesque operation is performed all is blue—both men and things.

The chemical preparation of these matches is relatively complicated. It requires care and skill. It is necessary, in fact, to dip the splints three times into the paste that covers their extremity in order that the head may remain in the form of a pear. The basis of this gray paste is potash, which is amalgamated with sifted sawdust.

Like the Swedish matches, the inextinguishable ones are covered with red paste which is inflammable upon prepared paper. They are counted and boxed by hand. Let us add that for these two kinds of matches the splints are paraffined.

We have already spoken of the operation of covering the boxes with the chemical composition, in which various ingeniously constructed machines concur. In the newest of these, the boxes that are to receive a coating of the scratch paste are inserted in a conduit which leads them between two rollers charged with the preparation. The boxes reach the hands of an operative, who arranges them in openwork frames, where they dry. The machine employed at Aubervilliers is based upon the same principle, but requires more manual labor, since every box has to be placed therein upon a roller, which covers but one of its sides.

We now come to wax matches, which are at present in universal use, and which are made at Marseilles. Their manufacture differs from that of the wooden ones only in the material employed. The dipping and removal from the presses are effected at Marseilles about in the same way as at Pantin. The boxing is done by hand. A slight blow of the finger given the presses when they are somewhat loose suffices to lay the matches and form a furrow that determines the exact number that is to enter each box.

It is interesting to see the match itself manufactured. For this purpose cotton thread in balls is used. These threads are combined according as need may be, in order to give the match more or less body. There are some matches of 10, 12, 16 and even 20 threads. The English require large matches, while the Italians, Spaniards and South Americans desire small ones.

In measure as the threads are combined, the element, that is to say, the wick, is wound upon a bobbin, which one takes care to place in a vast hall that is kept as cool as possible. Atmospheric heat has to be avoided so as to obtain a solidification of the stearine that is to cover the threads. This stearine, melted in a water bath, is collected in small pans. Through this is passed and repassed the wick, which

is calibrated very carefully by means of a steel draw plate. It is necessary to have a very uniform wick, first for the sake of the perfection of the work and second so as to employ only mathematically determined quantities. The least quantity in excess upon threads that ar infinitely larger than those of Ariadne would occasion great losses. The draw plates are therefore renewed every two days.

At the end of the immense hall there are big cylinders in which slowly wind the stearine coated wick. The long space that separates the pan from the cylinder permits of the cooling. Every time that it is desired to pass the wick into the stearine pan again, the cylinder is moved to the place occupied by the reel, and vice versa. Thus the operation is reproduced by the simple transposition of these two apparatus. Three operations suffice to well coat and perfect the wick. It now remains to cut it into the proper lengths. In the apparatus for doing this two feed cylinders introduce the wick by successive rows into the vertical presses and an automatic knife passing rapidly from one side to the other makes a regular and clean section. This motion is regulated at will.

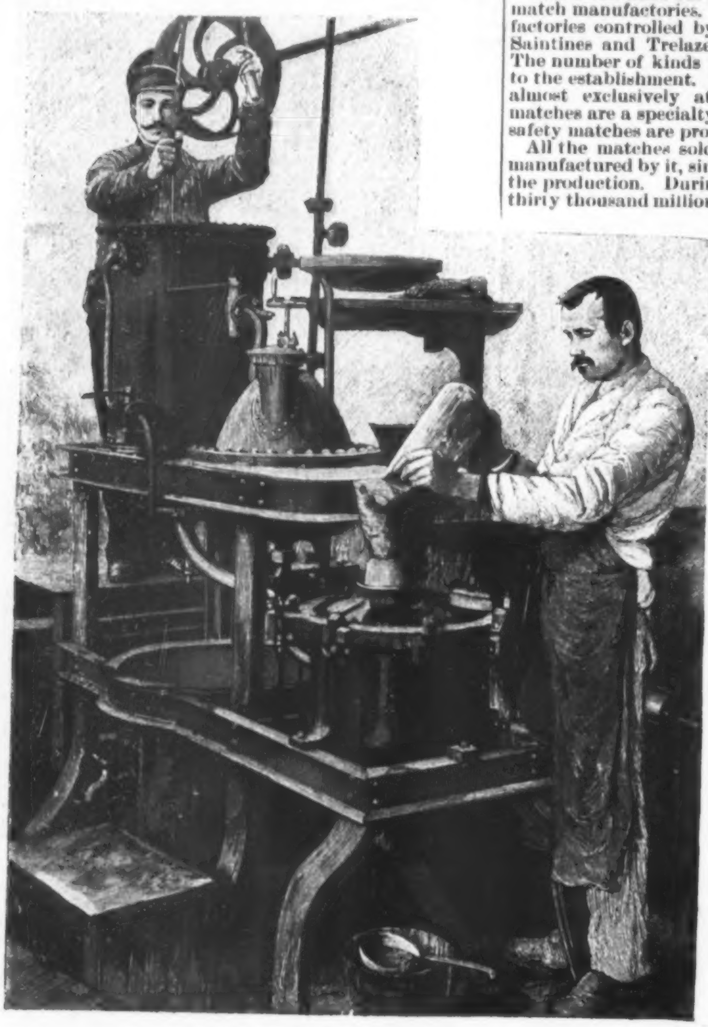
The dipping is done in the same way as with the splints. Let us remark, by the way, that the pastes used for tipping the matches of other manufactures are made at Aubervilliers. This is done in huge boilers whence a poisonous vapor escapes. Some of the workmen stir the paste, others transfer it from one vessel to another and others again draw it off. It is an abominable cooking operation.

The wax match, handsomer than the ordinary kind, is generally preferred thereto, notwithstanding its higher price. This is due to its cleanness, its small size and also its pretty box.

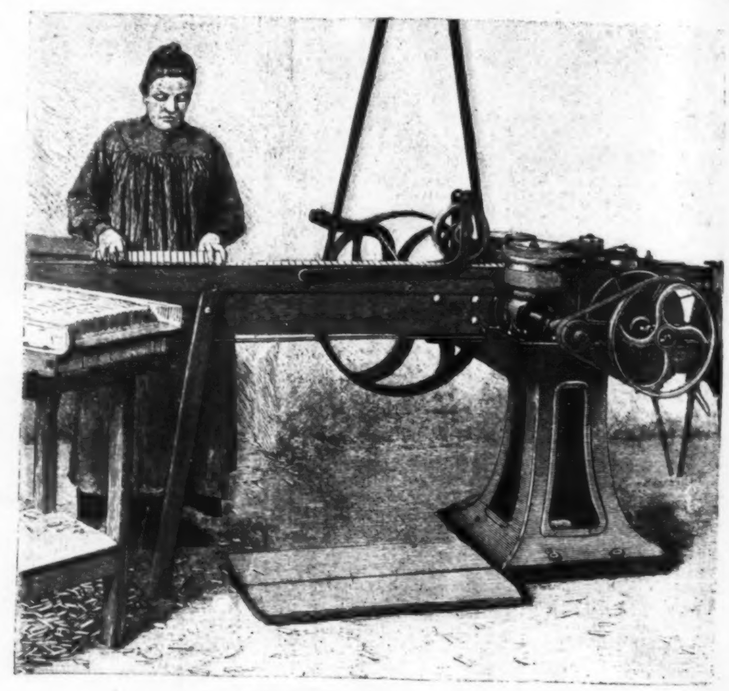
The nature of the boxes has an influence upon the prices of wax matches. Still, all are sold uniformly at three cents.

This terminates our promenade through the Pantin match manufactories. A visit to the four other manufactories controlled by the state at Begles, Marseilles, Saintines and Trelaze would teach us nothing new. The number of kinds manufactured varies according to the establishment. Wax matches are manufactured almost exclusively at Marseilles. Inextinguishable matches are a specialty of Pantin, and the Swedish or safety matches are produced at Saintines.

All the matches sold by the state, however, are not manufactured by it, since the consumption now exceeds the production. During the last year there were so'd thirty thousand million matches (or to be exact 29,951,853,596), which represents a mean annual consumption of 760 matches to each inhabitant, say two a day. As the state manufactories produced but twenty-seven thousand million matches, it became necessary to draw upon foreign countries, and 2,700 million were purchased in Belgium.—L'Illustration.



MACHINE FOR MAKING CHEMICAL PASTE.



FEEDING THE BOX-COATING MACHINE.

MACHINE FOR COATING THE BOXES OF SAFETY MATCHES WITH THE CHEMICAL PREPARATION.

RECEIVING THE CHEMICALLY PREPARED BOXES.

IN Australia horses and cattle are now being branded by electricity from storage batteries. The temperature is uniform and the brand safe and artistic.

MANUFACTURE OF MANURE FROM TOWN'S REFUSE.

THE advantages of water carriage, as opposed to what is generally known as the "pail" system of sewage disposal, have at different times been discussed with considerable heat. In connection with the claim made by the supporters of the latter system, that a much better manure can be made from the "pail" refuse than is possible under any system of combined water carriage and chemical precipitation, it must be admitted that the point is worthy of consideration, at all events, as far as the results obtained by the Manchester Corporation at their Holt Town Works are concerned.

Without going into details, it will be sufficient for our purpose to state that of the domestic refuse from about 70,000 pail closets and 40,000 dust bins with which the Manchester Corporation has to deal, about one-half is disposed of directly through their Water Street depot, while the other half (in conjunction with all the market garbage, condemned fish and meat, and the offal from the slaughter houses, etc.) is dealt with at the Holt Town Works, and it is to this latter portion that the following remarks are confined.

The collection is effected by two cartage systems, by one of which the closet and dust bin refuse is collected, the vans being specially made to hold twenty-four pails and the contents of an equal number of dust bins; by the other the street sweepings and market garbage are collected. To deal with the latter first. As the carts enter the works they move in a circle to a hopper on a level with the floor, through which the paper, ashes, garbage and what not fall into a long inclined riddle, being constantly tossed over by a number of attendants.

In this way all the combustible portion is separated from the fine ashes and dust, the latter being used for

a special purpose, which will be referred to subsequently. The combustible material just referred to is burnt under twelve 60 horse Galloway destructor boilers, thus supplying all the steam required for power and other purposes. The clinker from these furnaces, worthless as it may appear, is not yet done with, however, for after cooling it is ground and forms the basis of an excellent mortar, over 18 000 tons of which are annually made and sold at about 4s. per ton at the works.

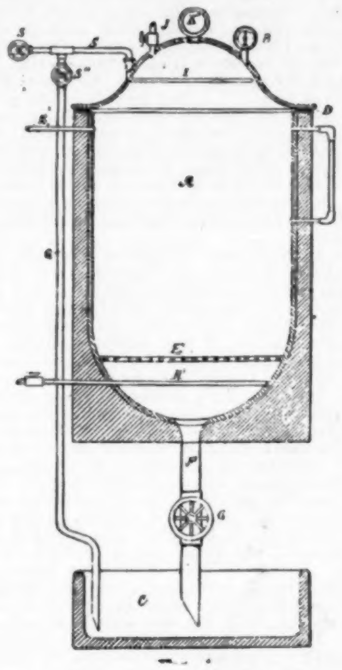
We now come to the "pail" refuse. This is collected in specially made galvanized iron pails, fitted with lids (closed hermetically by means of a rubber washer), which upon entering the works are speedily opened and tipped into a double hopper, the pails being immediately cleaned out and disinfected with a specially prepared disinfectant, made by mixing carbolic acid with the fine ashes previously described as being separated from the domestic refuse, etc. Returning to the contents of the pails, it is necessary to follow them on to the next floor, where a revolving steam riddle separates all the liquid from the solid portion, which is sold at once as night soil. The liquid portion, containing a small amount of finely divided solid matter, is run into store tanks fitted with mechanical agitators, where sulphuric acid is added to fix the ammonia, etc. From these store tanks this "stock" is run by gravitation, as desired, into a series of steam-jacketed driers, situated on the floor below. The manure is here reduced to a solid form, and a difficulty was at first experienced, owing to the extremely obnoxious nature of the steam and gases given off during the process. This difficulty has, however, at the suggestion of A. E. Fletcher, Esq., H.M. Chief Inspector of Alkali, etc., Works, been obviated by conveying the gases underneath the grates of a series of cremators, in which infectious materials are burnt up, by which means a complete combustion is achieved, and these gases rendered perfectly innocuous. The solid manure thus obtained is stored in large bins of very impressive proportions, from whence it is finally fortified, thoroughly mixed, carried by an automatic conveyor once more to the top floor, filled into bags and packed into the railway wagons standing on the adjoining siding.

The fortification of the manure is a point worthy of special mention, as the corporation guarantee the manure to always contain from 3½ per cent. to 4 per cent. of ammonia (in the same form as in guano), 8 per cent. bone phosphates, 0·75 per cent. potash salts and 38½ per cent. organic matter. To accomplish this end a competent chemist, equipped with a laboratory, continually tests the manure in the bins day by day, calculates the necessary quantity of ground bones and dried fish refuse necessary to fortify the manure, which after fortification and thorough incorporation, is once more tested prior to its being packed for delivery.

Seeing that the strength of the manure is guaranteed, the price of £3 per ton is decidedly reasonable, and this manure is worthy the attention of all farmers as being a very cheap and popular manure for all kinds of crops.

BLEACHING.

AN improved apparatus, involving in its use a new process for bleaching textile material in any form, is the invention of Cadoret and Jost, Crefeld, Germany. The improved process depends upon the principle that a liquid or gas injected into the pores of any substance



penetrates more completely if it meet no elastic medium in its course, and consequently if all gaseous medium or substance (such as air or other fluid by which a material is impregnated) is eliminated, the liquid or the gas will readily take the place of the latter, and if it possess special physical or chemical properties, it will impregnate every fiber of the material. If then it is desired to drive out these penetrating principles by the pressure of liquid or gas, it will be easy to do so without danger of objectionable traces, resulting from the separation of certain of these principles, remaining permanent. Thus for instance, suppose that it is desired to impregnate a compact woven fabric with a solution of any hypochlorite. By means of a vacuum the impregnation is readily effected, but it will never be possible by a vacuum alone to expel the solution entirely, for in the experimental conditions under which the industry is carried on it is impossible, whatever the system used, to create a perfect vacuum, and under such conditions it would be practically impossible to drive out all traces of the chlorine. If, however, when a certain relative vacuum is obtained the latter is destroyed by the sudden admission of a liquid or gaseous mass under pressure, the element previously irremovable will be driven forcibly out. It is this alternative use of a vacuum and of compression, produced in a special medium and in the order hereinafter pointed out, which constitutes the improved process.

The figure shows in vertical section the apparatus used, including as essential parts: A boiler connected by means of pipes with a blowing engine or other machine by which a vacuum and compression can be simultaneously produced; two pipes for the introduction of liquids or of gases, one being placed at the upper part and the other at the lower part of the boiler; finally, a spiral coil arranged at the bottom of the vessel to allow the heating or cooling of the treated material.

A is a metal vessel covered with non-conducting material and strong enough to resist external pressure when a vacuum is formed within and an internal pressure of several atmospheres. Its upper part is closed by a cover hermetically attached to it by an India rubber ring D and bolts. This cover is movable and can be raised and lowered or taken from place to place as required by a ring K fixed in it, and it is fitted with a cock J for the admission and discharge of gases, and with a pressure gage B. A spiral pipe I in its upper part, perforated with holes, is connected directly (by the pipe S and valve S') with the engine by which the vacuum and compression are obtained, and is provided with a branch by which, when a vacuum has been formed in the vessel, a liquid can be caused to flow from the upper part of the latter upon the substances placed inside it. Or, a pipe Q may be arranged provided with a cock or valve S'' and communicating at its upper end with the inlet pipe and coil I just described, while its lower end extends to the bottom of a cistern or tank C arranged below the vessel, any liquid in which can therefore be raised and discharged into the vessel. The vacuum is obtained in the boiler by connecting its upper part with the pumping engine by a pipe Z, and a glass gage V shows the quantity of liquid introduced into the vessel. A transverse platform E, open or perforated with holes, is fitted in the lower part of the vessel near the bottom and serves to carry the materials to be treated, and below it is arranged a pipe or coil H by which the contents can be heated or cooled. Lastly, at the bottom of the vessel is fixed a pipe F provided with a regulating valve G, which dips into the tank C below, or which may be connected when desired with generators of suitable gaseous compounds or volatile liquids. It will easily be understood that if any substance is placed in the vessel which it is desired to impregnate with a liquid for example, it is suf-

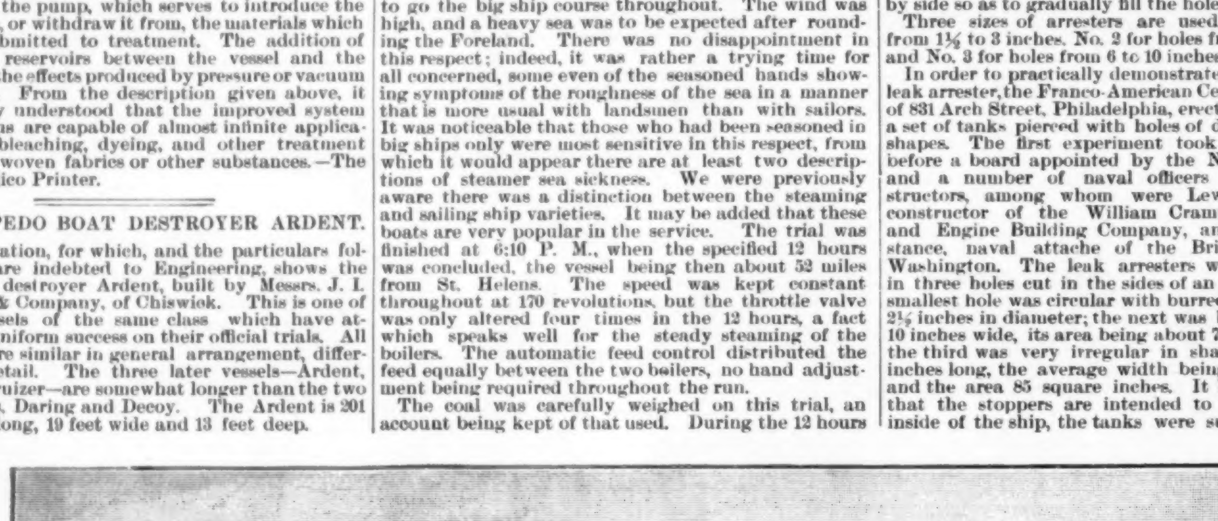
DESIGN FOR INTERIOR DECORATION.

From Moderne Innen-Decoration.

ficient to fix the cover and to place the pipe Z in the upper part of the vessel in communication with the air pump so as to produce a vacuum, and when this has attained the desired degree to open either the cock G in the lower pipe which descends into the cistern, or the cock S[3], which communicates between the said cistern and the pipe leading to the perforated coil in the cover (all the cocks being ordinarily kept closed), and the liquid in the lower cistern will re-enter the vessel either at its lower or its upper part. If, on the other hand, it is desired to force a liquid or a gas from the vessel, the cock S[3] in the pipe communicating between the perforated coil in the cover and the blowing engine is opened and compression is effected in the vessel. By opening the cock G in the lower pipe, the liquid is discharged from the vessel into the cistern below. The improved system allows the movements to be obtained in succession and continuously, as may be desired, and it consists of a development and practical application to industrial purposes of the displacement apparatus used in chemical laboratories, in which a liquid or a gas is raised by means of a vacuum and is then driven back by compression. A hot or cold liquid may therefore be made to circulate under the action of the pump, which serves to introduce the said liquid to, or withdraw it from, the materials which are being submitted to treatment. The addition of intermediate reservoirs between the vessel and the pump allows the effects produced by pressure or vacuum to be varied. From the description given above, it will be easily understood that the improved system and apparatus are capable of almost infinite application to the bleaching, dyeing, and other treatment described, of woven fabrics or other substances.—The Dyer and Calico Printer.

H. M. TORPEDO BOAT DESTROYER ARDENT.

The illustration, for which, and the particulars following, we are indebted to Engineering, shows the torpedo boat destroyer Ardent, built by Messrs. J. I. Thornycroft & Company, of Chiswick. This is one of the five vessels of the same class which have attained such uniform success on their official trials. All these boats are similar in general arrangement, differing only in detail. The three later vessels—Ardent, Boxer and Bruizer—are somewhat longer than the two earlier vessels, Daring and Decoy. The Ardent is 201 feet 6 inches long, 19 feet wide and 13 feet deep.



H. M. TORPEDO BOAT DESTROYER ARDENT.

The Ardent, Boxer and Bruizer had an increase in heating surface by a slight rearrangement of the tubes. There are three Thornycroft water tube boilers in each vessel, and the engines have one high pressure cylinder of 19 inches, an intermediate cylinder of 27 inches, and two low pressure cylinders of 27 inches, the stroke being 16 inches.

MEANS OF THREE HOURS' RUNS.

	Steam Pressure.	Revolutions.		Total. I. H. P.	Speed.
		Port.	Star.		
	Lb.				Knots.
Daring	198	380	378	4,409	27·706
Decoy	197	...	...	4,049	27·763
Ardent	195¼	398	394	4,306	27·973
Boxer	202	406	415	4,543	29·175
Bruizer	208	...	...	...	27·970

MEANS OF SIX MEASURED MILE RUNS.

	Steam Pressure.	Revolutions.		Total I. H. P.	Air Pressure.	Speed.
		Port.	Star.			
	Lb.				In.	Knots.
Daring	191·5	380	380	4,644	3	28·218
Decoy	191·0	366	365	4,009	3	27·641
Ardent	199·0	400	396	4,343	2¾	27·840
Boxer	201·0	410	415	4,487	2·6	29·080
Bruizer	204·0	...	...	.....	2	28·144

We take this opportunity of giving a somewhat full account of a consumption trial which was made with the Ardent on her run round from the Thames to Portsmouth.

The boat had been taken to Greenhithe, from whence she started at six o'clock on the morning of Tuesday, March 26. She ran to the Lower Hope, and made six runs on the mile to find the revolutions per knot at her then load draught with a speed of 13 knots. The maximum draught was 7 feet 4 inches with 30 tons of coal on board and a full sea-going equipment. It was found that with the engines giving 170 revolutions per minute, the required speed was attained. This was equal to 786 revolutions per mile. Two boilers out of the three were used with natural draught. The contractors had to deliver the boat to Portsmouth, but a navigating party, under Lieutenant Youell, R. N., had come round, Messrs. Thornycroft sending their own engine room staff, with Mr. George Brown as chief. The Admiralty was represented by Mr. W. J. Harding, of the engineering department, who has had a wide experience in connection with these vessels. Mr. John E. Thornycroft represented the contractors. As this was an economy trial, naturally the best was done to get the greatest distance with the least consumption of fuel, and it had been found by experience that a speed of 13 knots was most likely to give this result. This point will again be referred to later. The fires were kept light and a good deal of attention was given to their condition. The steam regulating valves were set to maintain a pressure of 180 pounds in the boilers, and the engines were linked up as high as possible. Observations and diagrams were taken every half hour.

Lower Hope Point was left at 7:18 A. M., the wind being on the quarter. Lieutenant Youell determined to go the big ship course throughout. The wind was high, and a heavy sea was to be expected after rounding the Foreland. There was no disappointment in this respect; indeed, it was rather a trying time for all concerned, some even of the seasoned hands showing symptoms of the roughness of the sea in a manner that is more usual with landsmen than with sailors. It was noticeable that those who had been seasoned in big ships only were most sensitive in this respect, from which it would appear there are at least two descriptions of steamer sea sickness. We were previously aware there was a distinction between the steaming and sailing ship varieties. It may be added that these boats are very popular in the service. The trial was finished at 6:10 P. M., when the specified 12 hours was concluded, the vessel being then about 52 miles from St. Helens. The speed was kept constant throughout at 170 revolutions, but the throttle valve was only altered four times in the 12 hours, a fact which speaks well for the steady steaming of the boilers. The automatic feed control distributed the feed equally between the two boilers, no hand adjustment being required throughout the run.

The coal was carefully weighed on this trial, an account being kept of that used. During the 12 hours 4 tons 2 hundred weight and 8 pounds of coal were burnt.

The indicator cards, about 240 in number, were worked out afterward, giving an average of 490·1 indicated horse power. This comes out 1·53 pounds per indicated horse power per hour. The fans were not running, but the steam steering engine and evaporator were in use all the time, about three-fourths of a ton of water being distilled.

There was more water in the boilers at the finish than at the start. A similar trial had been previously made with the Daring, the first of Messrs. Thornycroft's destroyers, but the speed then run was 10 knots. As both trials were for 12 hours, the Ardent naturally covered a greater distance. Thus the Daring made 120 nautical miles on her run, while the Ardent covered 156 miles. The coal burnt per mile, however, was approximately the same on both boats. Although the coal required per mile is the same at 10 and 13 knots, there is an economy at the higher speed, as the time factor comes in with regard to auxiliary machinery. There is no doubt, however, that the experience gained with the Daring gave some advantage to the Ardent trial in regard to the management of fires, etc. The economy of these water tube boilers will come somewhat as a surprise to many persons who look on them simply as spurting boilers of an extravagant nature.

LEAK ARRESTERS FOR SHIPS.

Experiments made by Mr. Colomes, a French inventor, with cellulose applied to holes in the hull, induced the French government to adopt his device to be used on board its war vessels.

The apparatus for applying the cellulose to the hole is extremely simple. It is composed of a steel rod threaded on a part of its length, at the end of which is pivoted an iron piece, which, when at right angles to the rod, has the appearance of a pickax, one of the arms of this cross piece being heavier than the other. This cross piece has fixed to it an oval piece of flat iron covered on both sides with thick felt. A small conical bag, filled with cellulose and having a hole through its center, can be slid on to the rod. Back of this bag is applied a large washer, which is held in place against the bag by a nut which is pushed down the rod to the threaded part, where it engages the screw. When a leak has been located any man can seize a leak stopper corresponding approximately in size to the width of the hole. Then holding it with the lighter end of the pick toward him, so that the pick and oval plate lie alongside the rod, he can introduce it into the hole. He can avoid the rush of the water by standing to one side. As soon as the pick has passed through the plating the heavier end descends, and the pick places itself across the hole, while the pressure of the outside water forces it against the side of the vessel and throws the pick arm across the opening, so, resting on the plating around the hole, it affords a point of support, while the felt covered plate reduces the leak very much and makes easier the next operation, which consists in slipping the bag of cellulose, washer and nut over the rod, screwing down the nut till the bag of cellulose is compressed against the hole. The cellulose bag fills up all parts of the hole, no matter how irregular, as the great value of the cellulose consists in its absorbing water and increasing its volume. This elastic mass makes a tightly applied mat over the hole, which cannot be accidentally disturbed or displaced. Should the hole not be more than 10 inches wide and several feet long, a number of leak stoppers can be used side by side so as to gradually fill the hole.

Three sizes of arresters are used: No. 1 for holes from 1⅛ to 3 inches, No. 2 for holes from 3 to 6 inches, and No. 3 for holes from 6 to 10 inches.

In order to practically demonstrate the value of the leak arrester, the Franco-American Cellulose Company, of 831 Arch Street, Philadelphia, erected at their works a set of tanks pierced with holes of different sizes and shapes. The first experiment took place last year before a board appointed by the Navy Department and a number of naval officers and naval constructors, among whom were Lewis Nixon, chief constructor of the William Cramp & Sons Ship and Engine Building Company, and Captain Constance, naval attache of the British legation in Washington. The leak arresters were to be placed in three holes cut in the sides of an iron tank. The smallest hole was circular with burred edges and was 2½ inches in diameter; the next was hexagonal, about 10 inches wide, its area being about 72 square inches; the third was very irregular in shape and about 21 inches long, the average width being about 5 inches and the area 85 square inches. It being understood that the stoppers are intended to be used from the inside of the ship, the tanks were supposed to represent the sea and the holes or rents were located at a depth of 10 or 12 feet below the water line, with a corresponding water pressure. The tanks were kept full by means of a pump so as to preserve the same head of water during all the tests.

The time employed to effectually close the holes under a head of water of 12 feet was as follows:

1. 2½ inch hole ....30 seconds.
2. 10 inch hole .... 1 minute.
3. 21 inch hole .... 3 minutes.

Another test made immediately after the above, using a water pressure of 9 feet, gave the following results:

10 inch hole........................ 37 seconds.
21 inch hole................1 minute 40 seconds.

During the latest tests made three leak stoppers were placed side by side, instead of two, in order to show that any number of leak stoppers can be employed to gradually decrease the leakage until the hole is under control. It is said that after the test Constructor Nixon expressed his opinion as follows: "The experiment was a signal success, and the holes were stopped in remarkably short periods. By the use of the Colomes leak stoppers and cellulose any leak in any vessel can be stopped before an appreciable quantity of water can rush in."

For holes of much larger area Mr. Colomes proposes to use a cellulose mat to be applied from the outside of the vessel. This mat resembles an ordinary mattress, filled with obturating cellulose, and is made in several sizes. The side of the mat away from the side next to the ship is covered with waterproof cloth, in order to prevent too much water from filtering through the cellulose. On the sides and at the corners rings are fixed intended to receive guiding ropes. Such ropes should always be kept in readiness on the upper deck, bent and with the slack so arranged that they will fall under the vessel so as to hang from gunwale to gunwale. These ropes are to receive the mats as soon as a leak is discovered and located. The soft, pliant nature of the cellulose lining of the mat enables the pressure of the water to force it into all parts of the opening, so that every crack is filled and the inflow automatically stopped.

The Franco-American Cellulose Company is now experimenting with a view to finding a non-combustible substitute for the woodwork of the cruisers and battle ships of the navy.—Proc. U. S. Naval Institute.

CAST IRON CHILLED CAR WHEELS.*

By WILLIAM W. LOBDELL.

CAST iron chilled car wheels are distinctively an American product, although manufactured to a limited extent in Austria and Sweden. The output, from possibly ten or twelve wheels per day in 1830, confined to, at most, two or three establishments, has grown to one of millions; the products of more than 100 establishments, controlling millions of capital and employing thousands of skilled workmen.

Comparatively few persons—even if actively engaged in railroad management—have acquainted themselves with their mode of manufacture and consequent characteristics, and, therefore, are often led into unwise conclusions as regards the limits of their efficiency. To such it may be interesting to note that when certain kinds of gray cast iron are melted and poured against a metallic mould, that portion of the iron next to the mould becomes hard, white, crystalline, and brittle, while the interior portion remains gray and more or less tough and fibrous. This conversion of the iron that comes in contact with the metallic mould into the hard, white variety is called "chilling," and it is upon this principle that the manufacture of chilled car wheels depends. This property of chilling, which certain irons possess, must have been known to ironfounders at an early day, for we have evidence of the fact that parts of plows, faces of forge hammers, punches for punching holes in wagon tires, rolls for rolling metal, and various other implements, were chilled long before the manufacture of car wheels.

As the early mode of smelting iron ores was with charcoal, it follows undoubtedly that chilled castings and chilled car wheels were originally made exclusively from charcoal irons, and although later developments have demonstrated that, under certain conditions, coke or anthracite irons possess this property of chilling to a certain extent, they have not come into sufficient prominence for us to consider them as important factors in this branch of manufacture, so that to produce the best results we may consider the use of charcoal iron as indispensable. All irons do not possess the property of chilling, and many that do possess it are not well adapted for use, because of characteristics which would render the wheels made from them unreliable.

Noting, then, this peculiar property of chilling, it is obvious that the plates and hub of the wheel must be cast in a sand mould, the result being that they are soft enough to be bored or machined, while the tread is so hard that the finest tempered file will not affect it. What, then, is this peculiar property of chilling? The supposition is that the chemical difference between the chilled portion of a wheel and the plates or hub is simply in the proportion of combined and free or graphitic carbon, that of the chilled part being high in combined carbon, the free or graphitic having been changed to combined by the rapid cooling of the tread by reason of being cast against a metallic mould, technically called a chill.

This rapid cooling of the tread of the wheel—the metallic mould in which it is cast being a good conductor of heat, while the sand mould against which the hub and plates are cast is a poor conductor—causes an undue strain upon the wheel, which must be relieved in some manner, or the wheel would be unfit for service. With the adoption of the form of pattern such as is used to-day came the necessity for some mode of slow cooling and annealing. Probably the first method practiced was to take the wheels from the moulds in which they were cast as soon as the iron was set, and cover them up in hot sand or ashes and allow them to remain several days until nearly cold. Another was to lay them on the floor and build a fire around the tread so as to bring the temperature of the tread up to that of the hub and plates, and then allow them to cool slowly. To a certain extent both of these methods accomplished the desired results, and were probably sufficient for the requirements of the times in which they were practiced. The latest and probably the best plan is to place the wheels, as soon as they can be removed from the moulds, in tight pits lined with fire brick or some other substance that will stand the heat, ten or more in each pit. The wheels are allowed to remain in the pits several days, and are not removed until all tendency to fracture from strain has been removed.

From this hasty résumé of the mode of manufacture, it is obvious that to insure a thoroughly safe and reliable wheel, great care must be taken in the selection and manipulation of the material used, as well as in the treatment of the wheel after it is cast; indeed, so well is this known, that the manufacture of chilled car wheels is considered as entirely separate from ordinary foundry practice, and it is carried on in establishments especially adapted to the work.

The efficiency of cast iron chilled wheels depends upon their strength and wearing qualities. If the specifications and physical tests formulated by expert mechanical engineers and adopted by the most prominent railroads of the country—and which are now much more severe and exacting than those first formulated—can be taken as the maximum required to meet the conditions of the increase in speed and weight of equipment of the present time, then the limit of strength of cast iron wheels has not been reached, as they are successfully met by all reputable manufacturers, and as long as charcoal irons can be produced approximating 35,000 to 40,000 lb. tensile strength per square inch, it is not likely that the limit of strength will be exhausted until the speed and weight of equipment are increased beyond anything now contemplated. Assuming, then, that cast iron chilled wheels meet all the requirements of the physical test and specifications as to strength and depth and character of chill, we have yet to consider their wearing qualities.

We have seen that the chilling process has transformed the iron in the tread of the wheel from a soft, dark colored metal with a semi-fibrous fracture into a metal white in color, hard in character, and with a crystalline fracture. If a proper mixture is used, this chilled iron is harder than any steel that can be safely used in a fire, and, consequently, under favorable conditions of service, should give excellent mileage results—instances being numerous where a mileage of 200,000, in some cases 300,000, miles has been obtained from 30 and 33 inch chilled wheels. These results cannot, however, be produced with the use of inferior irons, and they are not one of the conditions resulting from this era of extremely low prices.

The separation of the iron in the tread of a wheel into crystals by this peculiar process called chilling should indicate that, although it provided a wearing surface of extreme hardness, yet under certain conditions of service its peculiar crystalline structure would render it liable to defects not applicable to a metal of the structure of wrought iron or steel.

Such defects as are incident to improper manufacture, and for which the manufacturers are undoubtedly liable, we will not here refer to. We wish, however, to call attention to such defects as are incident to the service, and to impress upon railroad officials the importance of guarding against them as much as possible.

Probably more serious defects occur in cast iron wheels from the excessive use of the brake than from all the other causes combined. Excessive heat will destroy the life of the "chill." If by any process it is continued to a "red heat" point, it eventually transforms the crystalline structure back into the semi-fibrous. The application of the brakes, when severe enough to slide the wheel any considerable length of time, results in the heating of the tread of that particular point to such a temperature that a separation of the crystals composing the chill occurs, as can be noticed by fine fire cracks on the surface; further service results in a disintegration and shattering out of these crystals. As a result, shelled-out spots occur, such spots being readily distinguished by their ragged, cuppy appearance, and the absence of a high point in the center (like the defect termed a blotch, for which the manufacturer is generally held liable). If the tread of the wheel is broken through these shelled-out spots, the chill will be found to be discolored by the heat to a deep violet color, which discoloration can be produced in no other way.

That this peculiarity was not thoroughly understood by many railway officials is evident, as until lately in many instances they claimed that this was a defect for which manufacturers were liable.

The sliding of chilled wheels results not only in the disintegration and shattering out of the chill, but, by expanding the tread, in cracked plates and brackets, and other defects which necessitate the removal of the wheel. If the application of the brake could be more carefully regulated, the life and safety of the wheel would be increased a hundred per cent.

* Abstract of a paper read at the last annual meeting of the United States Association of Manufacturers of Chilled Car Wheels.

[FROM ELECTRICITY.]

OPPORTUNITIES IN ELECTRICAL ENGINEERING.

By A. A. ATKINSON.

PAPERS have frequently been published in the electrical journals deprecating the over-popularity of the electrical business in its various phases, claiming that the profession is already overcrowded, and upon this ground offering discouragement, sometimes in very strong terms, to the aspiring engineer.

It is only fair that an attempt be made to present the other side of the question. To this end this paper is written. For I cannot help seeing much encouragement in the outlook. Everything considered, I find electrical engineering in the broad acceptation of the words, if not on a flattering, at least on a very favorable basis as compared with other professions in regard to attractiveness, educational value and money return. In this it will be apparent that I am not at all Malthusiastic. I believe there is room and to spare.

Why should young men be discouraged from preparing themselves in a business and an electrical way to take charge of lighting stations and power plants, or any other practical applications, "because the growth of this business is not likely to be either sudden or rapid, or the opportunities offered particularly brilliant"? Should we say to the young man that has the aptitude and inclination for something else, "Stay on the farm, or in the shop, or in the store at $25 or $30 a month, because if you go into the electrical business, for instance, you cannot get more than $40 to $60 a month"?

Is it any more of an argument for the opposition to state that "the electrical railways at present do not seem to appreciate the need of trained men, and most of them are satisfied with their horse railway superintendents who have picked up enough of electrical information to make the cars run whether a dividend is paid or money sunk"? The statement refutes itself, for it certifies to the very conditions that do demand the right kind of men. Let the men prepare themselves and prove their necessity to owners of electrical stock. The only reason that such a condition exists is on account of the paucity of the men who are able by training to bring the business out of its present status. These and similar positions are not open to the merely technical and high-priced theorists. They belong to those who have been advised in the course of their instruction of the exact conditions and practically prepared for what is, not taught to expect big salaries and find or make positions to suit them. One of the things I also believe that often cast discredit upon the value of a college preparation is the lamentable failures of some technical graduates in attempting to manage practical electrical matters. And these conditions are not at all fanciful. Just such bad management is very easy to find in lighting and in power transmissions in all too many places. Just these conditions are the argument for better men trained for the right thing.

I grant that there are too many who enter the profession with the purpose of "making their mark," just the kind that are most apt to meet with failure. But as much can be said of any profession under the sun. I believe, also, that as the term "electrician" ought to be understood—not the electric bell and annunciator fiend—but few are needed. I grant again, that many applications are being refused by manufacturing firms—they themselves even failing and going out of business. Granted, that many classical graduates enter engineering schools to swell the ranks of that profession. All this admitted, I still contend that there are abundant opportunities for the pushing men who understand their business. Leaving out of consideration for the present the character of the positions offered in the various lines of professional and practical work, and looking only at the numbers studying for engineering in one or two instances, I know personally that in one or two institutions, whose catalogues were quoted by Mr. Floy to show the great number of students of engineering, at least six to eight times as many are at the same time registered in the law departments alone, to say nothing of the medical and other professional departments, aside from the single professional schools in cities everywhere. Even if we should admit that only one-eighth as many men are required in the varied lines of electrical work as in the legal pursuits, still we are on favorable ground, with not the least reason to deprecate the number.

The value of the electrical engineer, and hence his success in the business undertaken, will depend on three things, namely: natural ability and aptitude of the individual, the character of his course of training, and the general view of the situation with which he leaves college. And this will lead us to consider the relative advantages of a purely technical and a practical education. Of course the third condition of success may result from either of these. But before undertaking either course the individual must satisfy himself by a study of his proclivities, so to speak, whether he has any ability and inclination in the direction of electrical engineering. He need not enter the profession for money or fame if he does not like to work out the course, practice and theory, almost as well as to eat. Certainly, if he study only for the mental discipline and for a personal knowledge of the subject, this would not be true to the same extent. Or if his desires run toward business, law, medicine, sport or idleness, he will not succeed as an electrical engineer. But supposing that we have to deal with those only who should properly be engineers, so far as opportunities in life suggest, what kind of course shall be selected?

There has been a great deal said by way of discussion as to whether it will be most in accord with the fitness of things to educate the student along broad and general lines as a basis, and allow him afterward to specialize in any direction he may wish, or to train him directly in the applications with which he must have to do, only giving him enough of the technicalities to serve as a basis for future work in case he should have the opportunity or inclination to pursue such a course. These may properly be classed as technical and as practical courses. In other words, I shall call technical that course of study in which are included a rigid course in higher mathematics, advanced mathematical physics, the higher mathematical theory of electricity and much mechanical engineering. These fill up most of the first three years of the course. The fourth is devoted to laboratory work in measurements, dynamo tests, engine tests, lectures on the telegraph, turbines, heat engines, and finally a thesis. The entrance to such a course generally requires of the student qualifications such as would admit him to the freshman classes in any literary or scientific course. On the other hand, I shall call practical that course of training in which the mathematics, physics, chemistry and mechanical training all look toward the engineer in practice, and which includes such parts as will be directly available for him in his everyday work, leaving the refinements for his own individual filling in afterward, instead of teaching him the refinements and sending him out to fit some of it, if he can, to whatever application he may.

By way of further suggestion of the distinction from the purely technical, let me say that the practical course will include lectures and practice in wiring for the various kinds of distribution for lighting and power; calculations for alternating and direct current wiring under various conditions; the theory and application of electricity for railways, stationary power, lighting purposes, including the modern types of machines, direct, alternating and polyphase; designing and calculations for the winding of dynamos and motors; theory of steam, with practical instruction in the care and operation of boilers and engines, dynamos and motors. His knowledge of lighting and power distribution will be enlarged by model plans and specifications drawn up by him to meet certain requirements in railway and central and isolated station work. More and more detail will be required in this as the student progresses until he is able to draw and specify for actual work. We could go on further in contrasting the two lines of study, but it will be apparent to almost any one stopping to give the matter any consideration what their distinctive features must be. The one a very general basis upon which any application may be built by a sort of second experimental training, while the other is intensely practical in all its aims and work. The one may develop the theorist, the electrical investigator, the electrician; but even here real practice in the bone labor of the profession would be of much benefit. The other will produce the artisan, the superintendent, the installing and consulting engineer. So, that, assuming in both cases that the student has been apprised of the difficulties and necessities—in short, the real situation confronting him—in order that he may not go out with puffed or false ideas, each course prepares for a different line of work. Of course the one line may develop afterward into the other.

The question now is, with conditions as they are, which offers the most to the young man? So far as it can be seen at present, considering the number of positions open, the practically educated young man has the advantage, though if the technical graduate be willing to begin low in order to learn the practical elements of the business and to convince his employer of his superior ability and skillfulness, he will find plenty of opportunities for promotion; he can then leave the lower position to another beginner. But unless he be willing to do this, the practical man who is, in a sense, previously prepared for work in any application has much the advantage. Besides, he knows the practicalities, the other has them yet to learn.

I believe the day is past when we should expect new and wide applications to develop suddenly to require the services of a number of men; the surprises in lighting and power transportation are not in the future. When these things were new, men not educated had to fill the positions; horse drivers became motormen, fire stokers station men and steam engineers "electricians." Now as these industries widen,

and that rapidly, the great problems are a more efficient service, stricter economy in all directions and a gradual weeding out of the undesirable, thus making room for those prepared to render the best service.

Necessarily this process has been slow for several reasons, but now that the various departments of the electrical business have become permanently established, this will be more rapid. The bad wiring, the wretched installation, the miserable economy of operation which have prevailed in the majority of cases in light and power plants for small towns, and also in very many not so small, will gradually disappear, because the services of trained men are beginning to be appreciated and sought. For the same reasons new installations will be manned by those who are prepared for the work.

I can probably best indicate the situation to the electrical student by outlining the kinds of positions that may be open to him. So, not by any means including all, but serving as a broad basis of division, let us lay down the following:

(1) Original investigation and invention. (2) Consulting and instructing engineer. (3) Superintendents of light and power plants, including isolated and central station work. (4) Stationary power, railways, mining, etc. (5) Artisans in light and power. (6) Artisans in factories. Those belonging in the first class I shall call electricians. Those in the second, third and fourth classes may properly be denominated electrical engineers. To be sure, this is not meant to consider those cases where some member or stockholder of the company is made "superintendent," whether there is an engineer besides him or not. If he has not the electrical knowledge, and does not actually superintend the electrical part of the work, his title is a misnomer.

Properly, in small towns where this is done, he should be superintendent or business manager of the "company" and not of the plant or works. It will be quite evident, also, that the station man in a small plant, who also looks after the wiring and general repairs, is not entitled to the distinction of electrical engineer. He is merely an artisan, and the plant and town are without an engineer. I assume in this connection that only he who has practically passed through the preceding steps and has arrived at the point of being the real superintendent of all the construction and repair of electrical appliances, whose theory and practice and experience entitle him to this distinction, shall be called electrical engineer in the sense in which I am using the title.

Under 5 and 6 I mean to include all, highest to lowest, engaged in actual work in manufacturing establishments, and in the actual operation of electrical appliances in lighting and power.

As to numbers, we observe that those belonging to class 1 are comparatively few. Their preparation will be of the highest kind, technical and theoretical. The work of research must be undertaken only by those who have an intense love of the truth for its own sake, and are willing to devote many weary days to its search with the expectation of no other reward than the great satisfaction of having added something to the world's knowledge. Science may indeed pause to do them tardy honor. Men of this stamp we all can name, and none are more deserving of the world's gratitude for their noble sacrifices in behalf of truth. Such men have established the laws of chemistry, physics and electricity—indeed have built the foundations of knowledge in all lines.

They have established the bases for the modern applications of science, and they have invented practical devices for applying their discovered principles. They have given us the photophone, the phonograph, telephotography, the telautograph, the possibilities of electrical welding, heating, cooking, transportation and hundreds of others. And yet their work is not done. There are the problems of light without wires, the real nature of electricity, light and power without the present wasteful methods—perhaps by maintaining very high frequency vibrations—electrical energy directly from the sun, methods of improving the magnetic circuit of dynamos, earth telephony, etc.

Very little need be said about class 3, for the number of places is necessarily limited, being open generally only to those who have received a special training in the factory itself. New establishments select men of experience from factories elsewhere. But those who are fortunate enough to secure places as artisans are the material—some of them—out of which those more enviable men are made.

There are much greater opportunities in class 2 and these will be on the increase. As the tendencies are more and more to stricter economy, least first expense and more efficient service in general, the electrical engineer will be more and more in demand. The time is rapidly approaching when every central station, lighting and power, and every form of electrical business, will have their consulting and installing engineers. The preparation for this work must be founded in practice. Without going into detail, it is apparent that the technicalities of engineering alone will be of little avail. The reason for many failures in the successful installation and operation of electrical plants has been that the "theories" of those in charge were not backed up by a thorough practical knowledge and experience.

Classes 4 and 5 have the advantage of by far the greatest number of individual opportunities; and as the financial condition of the present improves, this will be true in a still larger measure, since capital being less conservative will hasten to invest in the business which when rightly managed promises the largest per cent. on the outlay. The gradual adoption of electricity by steam roads and by new competing roads joining important centers, the rapid extension for lighting into the towns everywhere, the enlarging of existing plants to meet the exacting demands for greater and better service, the extension of electric power into mines and other forms of industry—all will have the effect of opening up new and wider opportunities. But in the same proportion there will be the greater demand for more thoroughly prepared men. This needs no particular illustration; but to take a single instance, lighting, as representative of the situation in general, it has been stated on good authority that if electricity should supplant gas for lighting purposes, the cities of New York and Philadelphia alone would at once require all the dynamos and lamps now in use in all the United States. I believe this is what we are gradually but surely coming to. With the inevitably cheaper production and more satisfactory results gas must die hard after a severe struggle, the Welsbach with its other devices. It can readily be seen what the advantages of electricity are, and the people will demand and get it. It needs no argument that the preparation for these two classes must be a thoroughly practical one—practical in the sense in which I have been taking it.

Under the head of 6 comes a number of positions, though much smaller than under 4 or 5. On the whole, these places are not so desirable, since the chances for advancement will be limited to very few in this line of work.

From the foregoing outline it will be apparent that the men educated along what I have called practical lines have far the better chance for promotion under the present conditions, and the places they are at once able to fill are much more numerous. The technical graduate is prepared for 1. True he may work in 2 and the rest if he first goes to work to prepare for them by practical study and experience, either in school or under private instruction, with an apprenticeship. This done, his higher instruction will be of much advantage to him. But I cannot help deprecating the tendency of our so-called technical schools in their instruction to sail off into the generalities, refinements and abstractions to the neglect of those things which are more essential for the immediate use of the great majority of their graduates.

I wish to repeat that there are and will be opportunities abundant for those rightly educated. In numbers they compare at least very favorably with those in other professions. Students must of course be taught the difficulties of low salaries at first—not speaking of the many favorable exceptions to this—hard work and perseverance. But is this any less true in most other kinds of business as a rule? One great reason for the apparent overcrowding of the electrical profession is that so many are educated for positions that do not exist, instead of preparing to meet the conditions as they are.

Athens, O., April 17, 1895.

A DECORATED KITE.

ONE of our readers of Reims sends us a photograph representing a kite of quite a respectable size, as may

A DECORATED KITE.

be judged of by observing the child that holds it in a vertical position. This kite, which passed through the hands of an artist, was converted by means of a skillful brush into an aerial female of fantastic aspect. Our correspondent writes: "I send you by mail a photograph of a kite 2·25 meters (7½ feet) in height, painted by one of my friends, who, like myself, wishes to preserve an anonymity. Perhaps you may think it apropos to submit a reproduction of it to your readers." This we hereby do. We find that the composition of the decorated kite is very original, and we congratulate the author of it.

The kite is a very amusing device, and one that is interesting to construct and very curious to experiment with and study. Those who delight to fly it will find here a decorative idea which may be applied for obtaining various effects.—La Nature.

KITE AND FLAG FLYING.

THE man who flung the stars and stripes to the winds of heaven at an altitude of 2,500 feet at the recent dedication of the Washington Arch, in this city, was Gilbert F. Woglom, a jeweler. He is, he says, a student of aero-dynamics. He is a scientific kite flier.

The line that held the flag on the occasion was suspended from six kites. The people who cheered and got themselves into a true Fourth of July spirit saw only four kites. That was because one of the kites was blue, and was literally out of sight in the sky. A second kite struck a stratum of wind that carried it away from the others, so that it did not attract attention.

Mr. Woglom, Prof. William E. Eddy, of Bergen Point, and Capt. Isaac Cole, who is an old sea dog, went up into the tower of the Judson at 2 P. M. Mr. Woglom owns about sixty kites. Each one has its name, and judging by their names, some are male kites and some female. He took six kites into the tower with him, all stretched on light but strong frames of spruce wood and braced with fine copper wire. The length and breadth of each kite was exactly equal.

The wind at first was blowing at about thirteen miles an hour. The three experts on kites first sent up one named Grace, which is covered with red China silk and is forty-two inches long and broad. After numerous experiments Mr. Woglom has concluded that China silk is the best covering for a kite. The next best is tough rope manila paper.

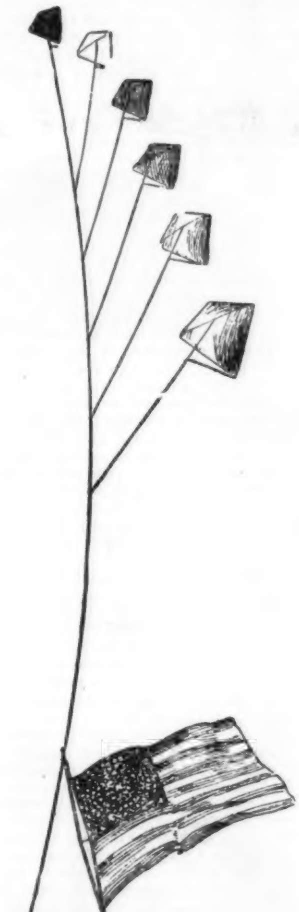
To Grace was fastened the main kite line. The only difficulty was in raising Grace. At last she was caught in a steady current of air, and aloft she soared. At a certain distance from Grace another kite, the Lady Harriet, was attached to the main line by a

GILBERT F. WOGLOM.

whip line. The Lady Harriet is covered with white China silk and forty-six inches long. Then the kite Dainty, the sky blue one, which is fifty inches long, was sent up in exactly the same manner, then the Bullet, fifty inches long and covered with buff-colored rope manila paper; then the Rockwell, fifty-six inches long, and then the kite Dick, fifty-two inches long.

When the six were straining at the main line, Mr. Woglom tested their pull with scales such as icemen use, and found they had a pull of sixteen pounds.

The flag was of bunting, 8 feet long, and with its staff weighed $1\frac{5}{8}$ pounds. The top of the staff was securely fastened directly to the main kite line; the bottom of the staff swung loose, save that a piece of stout twine long enough to keep the staff at a



Six kites carried the flag 2,500 feet above the crowd in Washington Square.

constant perpendicular was extended between it and the main line. Up went the flag, unfurled itself, and stood out stiff as a board—radiant and beautiful, sunkissed, glorious.—N. Y. World.

LEGISLATIVE PREVENTION OF BLINDNESS.

SCARCELY a day passes that the public prints do not contain at least one item that shows how the diffusion of knowledge is working among the non-medical portion of the community in causing energetic prevent-

ive measures in many directions. A few days ago the governor of New Jersey signed a bill "To Prevent Blindness," and at first sight it looks like an act of presumption on his part; but when we look a little further, and see what wise legislation fearlessly and faithfully enforced can do, the subject takes a new interest, and we find that its bearings, both economic and philanthropic, are highly important. Twenty-five years ago it was found that about one-third of all the persons in the blind asylums of Europe had become such by ophthalmia neonatorum, or the "blindness of the newly born," as the majority of these cases are past hope of successful curative treatment at the end of the first four weeks of life. Bacteriological discovery has put a new face on the whole matter, it has demonstrated the microbian origin of the trouble, and along these lines has the certain remedy been pointed out. Switzerland was the first country to adopt preventive legislation, but legislation needs to be enforced, and this is a case which affords many loopholes for escape. A law was passed in 1865, and Professor Horner took up the enforcement of the law as a matter of personal enthusiastic zeal and championship; and the evaders knew they had a relentless vigilant watching them, in him, and he had the satisfaction of knowing that no child was admitted into the large blind asylum of Zurich which had lost its sight since 1865 from this cause. It needs a devoted enthusiast at the heart of every "cause" to render it triumphant. Compare the fact that in the Sloane Maternity, where the children are under the care of highly educated physicians, and where among four thousand births in the last six years there has been no case of this disease of any account, and the former ratio of one-third of the adult blind having lost sight by the early neglect of ignorant midwives, nurses and attendants. To Crede belongs the credit of demonstrating the efficiency of a competent germicide—at the very outset—extinguishing the flame before it was fairly under way, and now there are next to no persistent cases in all the great hospitals of the civilized countries; but the moment you get beyond their walls, a very different state of things is found.

It is safe to say that the loss of sight in one or both eyes from this cause is the direct result of ignorance or neglect, and when we know that there are to-day in the United States at least 10,000 persons rendered blind by this cause alone, we begin to perceive the density of the ignorance and the widespread neglect. What does an ordinary nurse know of the inroads of bacilli—their origin, growth, effect, and of how to counteract their mischief? Above all, what does she know of the rapid destruction they can set up in the human cornea? She contents herself with the formula, "They'll clear up after a while," and continues to apply her tea leaf poultices; while beneath them the bacilli are multiplying by the thousands and destroying the very tissues of the "windows of the soul." At last, when the poor mother learns that her child cannot see, she takes it to the infirmary or to some kindly oculist. He says: "You should have consulted me four weeks ago; the time to save the eyes is past;" and with a heavy heart the poor mother turns away, bearing with her one "item" in the account that goes to make up the million and a half dollars that are paid to support the blind—if this episode has happened in New York State.

New York took the lead in enacting a law (1890). Her example has been followed in Ohio, Maryland, Maine, Rhode Island and perhaps others—certainly in New Jersey; but the five years that have passed in New York since the passage of the law clearly show that something more than the enactment of law is needed; for, says Dr. Charles H. May, a high authority, "the ophthalmic dispensaries of New York City treat almost as many cases of ophthalmia neonatorum, in proportion to the total number of eye cases, as they did before the passage of this law;" and he proceeds to formulate what he thinks might be salutary changes in the law. But it really needs a self-sacrificing enthusiast to see it enforced. The greatest obstacle is ignorance—ignorance that there is such a law; and there are still many thousands who should know not only the law, but the hope of help that it holds out to those who are unaware of it.

It has seemed that every phase of philanthropic work has its "society" and its organized corps of workers; but we suggest one more—"The society for the diffusion of the knowledge that, by obeying the law, 500 children in New York City alone can and should be saved from blindness each year."—The Independent.

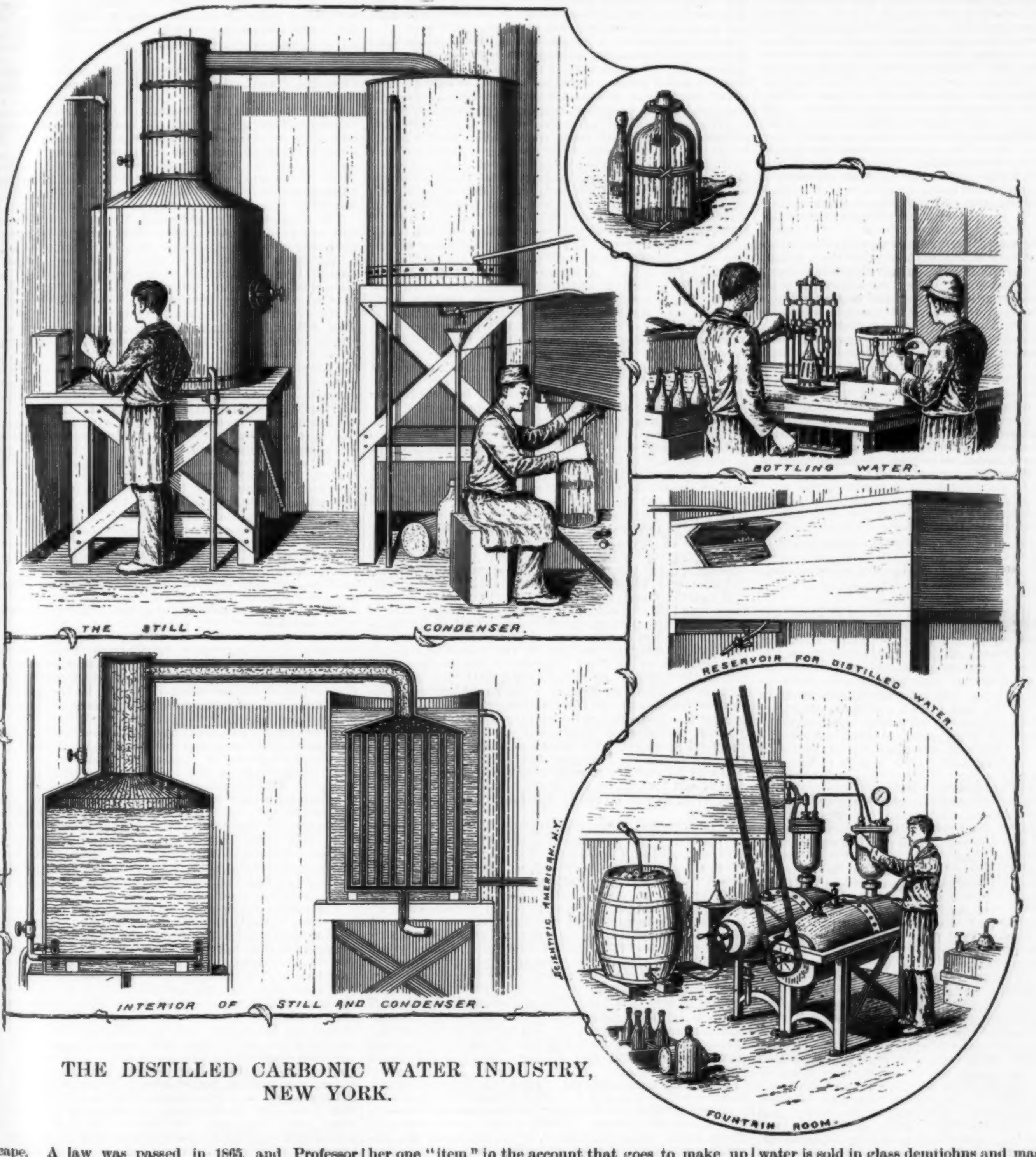
MANUFACTURE OF DISTILLED CARBONIC ACID WATER.

DISTILLED water is manufactured principally for general family use, the process of distillation purifying and making it a good, pure and healthy drinking water. The distilled water used for the table in hotels and by private families at dinners, weddings, etc., is, after distillation, charged with carbonic gas, which makes an agreeable beverage said to promote digestion.

It can be used with the utmost freedom, without any of the ill effects which often arise from the use of highly mineralized or medicinal waters. The pure distilled water is sold in glass demijohns and magnums and the carbonic table water in cases containing pint and quart bottles.

The apparatus in which the water is distilled is connected to the street pipe, the water passing into the still at the top through a two inch pipe. The still is made of copper one-eighth of an inch in thickness. It is four feet in height and about three and one-half feet in diameter. The dome, connected to the still through which the steam or vapor passes, is about twenty inches in diameter and about four feet in height. The still is lined on the inside with block tin and holds about six hundred gallons of water.

The water is heated by a steam pipe from the engine room, which connects with a coil of two inch block tin steam pipes lying on the bottom in the interior of the still. The scum or dirt from the boiling water is passed off by means of a pipe connected to the bottom of the still and run into the sewer. Fifty or sixty pounds of steam is used for heating the water. From the dome the live steam passes through an eight inch pipe to the copper condenser or cooler, where it condenses, forming distilled water. The cooler is also lined with block



THE DISTILLED CARBONIC WATER INDUSTRY, NEW YORK.

tin and is about six feet in height and about three feet in diameter, and holds about six hundred gallons of cold water, which runs in from the street.

The pipes in which the water is distilled are about two and one-half inches in diameter and about fifty in number, and are connected to the eight inch copper pipe at the top of the cooler. The pipes are bunched together in a circular form and stand upright in the center of the cooler. The steam as it passes into these pipes is instantly chilled and forms water, the low temperature of the water by which the pipes are surrounded producing the change. A continuous stream of cold water is run into the cooler from the street, it being kept from overflowing by means of a waste pipe at the top.

From the condensing pipes the distilled water is run through a two inch pipe connecting with the bottom and run into a tinned lined reservoir about ten feet in length, two and one-half feet in height and two and one-half feet in width, holding about two hundred and fifty gallons. From the reservoir the distilled water for general use is run into demijohns and magnums.

The table water which is charged is first run from the reservoir through a coil of pipe surrounded with ice-cold water. From this coil of pipe the distilled water is run into the charging fountain. The fountains are made of cast iron, lined with block tin, each apparatus having a shaft running horizontally through the center, connected to which are a number of arms which, when in motion, stir up the material within. The gas (carbonic) is formed by first putting into one of the fountains five gallons of marble dust and about fifteen gallons of water. Into this mixture about one gallon of oil of vitriol is slowly added. The turning of the wheel connected to the end of the fountain causes the shaft and arms to revolve in the interior, which in turn mixes up the ingredients, causing carbonic acid gas to form. The gas is then passed into the purifier of the other fountain.

After about twenty-five gallons of the distilled water has been run into the fountain, the gas is then admitted, which has a pressure of about seventy-five pounds to the inch. The shaft is then set in motion, the revolving arms thoroughly mixing the water and gas together. To keep up the stock of gas it is necessary to turn occasionally the shaft of the gas fountain a few moments. After the gas and distilled water has been thoroughly mixed, it is run from the apparatus through a flexible pipe to the bottling machine, which is so constructed that the attendant by the use of levers can fill and cork about eight hundred quart bottles per day. The filling and corking is done so quickly that very little gas escapes. The corks are then made secure by the attendant twisting a fine piece of tinned wire over the top of the cork and around the neck of the bottle. The sketches were taken from the plant of the Krystaleid Water Company, New York.

CHEMICAL INDUSTRY AT THE CHICAGO EXHIBITION.*

IN this report we have a view of the present condition of chemical industry, its novelties, and its prospects for the future, from a standpoint not the same with that occupied by Dr. Witt, and it presents much that is thoughtful and worthy of study.

Noticing the United States as a country of great but very imperfectly developed resources, among which he counts abundant water power for the future extension of electrolytic processes under favorable conditions, the reporter considers Germany, England and France as the great seats of chemical manufactures for the supply of the world at large, and contrasting the progress of these three, for the last fifteen or twenty years, he recognizes that Germany has advanced most rapidly, her gain in position being most marked within the period named, for which he examines the statistics in some detail, but dating back to the middle of the century, to the era of the birth of structural and so-called synthetic organic chemistry. He finds the causes of German success in the practical rather than idealistic character of the Germans, their talent for organization, and their habits of discipline, which render possible combined effort on a large scale in industrial enterprises, and in illustration he points to the value of the "Syndicate of Chemical Industry" in the united influence it has brought to bear upon legislation as to patents and in other directions. But he lays especial stress upon the importance of German organization of scientific thought, education and research. He is deeply impressed by the force gained from freedom in teaching, freedom in learning.

He sees in the professor of a German university, not merely a medium for the transfer to pupils of already acquired information, but a former of minds and a pioneer of knowledge, a man whose best recommendation to official appointment and to promotion has been his reputation for original work, who has placed at his disposal the most ample material appliances for work, and who, as a scientific man, is more highly regarded and enjoys more social consideration in his own country than anywhere else in Europe. The writer points out the close connection established in Germany between the industrial application of scientific knowledge and the continued extension of that knowledge, so that there manufacturing chemistry, including research, offers a career to the scientific chemist who has been trained at a university, and quotes the fact that four of the largest German firms among them give constant employment to more than 230 chemists, a large proportion of whom are engaged solely in original research. German industrial success has been most conspicuous in the directions in which scientific chemistry has made most rapid progress, in organic chemistry, in the production of the coal tar colors, of medicinally used chemicals, of artificial perfumes, of explosives.

England holds, as her main strength, to the production of the simpler mineral chemicals in gross, the manufacture of acids, alkalies (or rather alkali, since the possession of the unique Stassfurt deposits gives Germany essential control of the production of potash) and mineral salts. It is remarked that in England chemists with more or less scientific training are employed by manufacturing firms, but not to any great extent for purposes of research, and that they are, as a rule, but poorly paid. There might have been added unfavorable comment upon the ill effects of the reign of examinational cramming which has borne heavily upon English scientific education for the last quarter of a century or so, though vigorous protests against it are not lacking from some of the most competent English sources.

M. Haller, himself director of the Chemical Institute of the Faculty of Sciences of Nancy, finds much to lament in regard to the falling back of France in the race for success in chemical industry, and in regard to the causes which seem to him to be concerned in this. He regrets the failure to revise legislation on the subject of patents since 1844, the exorbitant tax upon the alcohol which is so much needed in modern organic chemistry, but, above all, what he considers serious defects in respect to scientific organization and scientific education. He quotes the clear-cut words of Taine on the deadening effect on higher education of the spirit of authority, and of fixed rule and programme, ending with exhaustive and exhausting examinations; the human product thus characterized: "Leur vigueur mentale a flechi; la seve feconde est tarie; l'homme fait apparait, et souvent c'est l'homme fini."

Scientific education in the United States is not spoken of by the reporter at much length; probably his opportunity of examining it for himself was not very ample; but it seems to him, more than in Europe, and solely because of the conditions belonging to a new country, "d'un caractere trop positif, trop pratique, trop immediatement utilitaire en un mot, pour qu'il puisse donner tous les fruits qu'on est en droit d'en attendre." What is said in expressing a desire for new establishments for higher scientific education in France deserves attention in this country, that there is danger by multiplying too much such establishments of lowering the grade of instruction, and of the results attained. There is only a moderate amount of sound human material, professors and students, leaders and led, available in the country at any one time for higher education in the proper sense, and concentration of this, to a reasonable extent, is surely desirable. Those who have seen much of American educational work can hardly fail to recognize among its weak points a good natured readiness to be not too critical, but to pass over lightly the confusion of real with self-claimed merit, and to allow every school to call itself a college, every college a university, without its being a part of any one's business to draw overnice distinctions on such questions. No doubt much of this will remedy itself in time, and those who can look back thirty or forty years have already seen great improvement.

Under the head of "Produits de la grande industrie chimique," the reporter has an interesting discussion of the question whether the electrolytic decomposition of common salt is soon to become the mode of utilizing its constituent elements, with both of which—sodium and chlorine—nature supplies us abundantly in but the one form of this important substance. He speculates on the profound changes which will be brought about by the industrial electrolysis of salt in the other processes of chemical industry which have hitherto been connected with and dependent on the Leblanc process. He notices the fact that already electrolytic chlorine and bleaching powder, potassium chlorate, and caustic potash have been successfully made from the potassium chloride of Stassfurt carnallite. Notice is taken of the plan adopted at Leopoldshall for making the osmotic diaphragms of parchment paper permanent; namely, by adding on the anode side about two per cent. of calcium chloride or magnesium chloride to the brine to be electrolyzed, with the effect of forming an adherent deposit of an oxychloride of calcium or magnesium on the diaphragm, which serves to protect it. Liquefied chlorine placed upon the market in steel cylinders is mentioned as one of the newer chemical products. We have a discussion of the various attempts since 1889 (the date of the French International Exposition) to recover in useful form the chlorine of salt treated by the Solvay ammonia-soda process, with, as yet, no really satisfactory solution of the problem.

Improvements in the manufacture of sulphuric acid are limited to the means of concentrating the acid. The apparatus of Scheurer-Kestner is intended to effect a partial concentration in a platinum vessel, followed by final concentration in one of cast iron, the transfer from the one to the other being made when the strength attained begins to entail considerable attack of the platinum and the acid ceases to appreciably act on the cast iron. An apparatus on this principle required but 18·8 kilos of platinum, the iron part weighing 250 kilos; 4,500 kilos of sulphuric acid of 95 per cent. could be turned out in twenty-four hours, and the loss of platinum was not more than 0·15 gramme per ton of acid of 66° B. The gold-coated platinum of Heroeus is mentioned, with notice of the permanent and satisfactory union of the two metals brought about by casting the gold on the surface of previously heated ingots of platinum and rolling down the compound bars so produced.

The interesting proposal of Blount is not overlooked, to concentrate the acid in a glass or porcelain vessel by a platinum wire spiral heated by the passage through it of an electric current. A wire 5 mm. in diameter and 77 cm. long, heated to 480° C. by a current of 364 amperes (at 5 volts), sufficed to concentrate 24 kilos of acid in five hours; this represents a consumption of five times as much fuel as would be required for direct concentration, but water power would afford a cheaper source of power, and the quantity of platinum required is very small, while any loss from electrolytic action might, it is suggested, be avoided by using alternating currents.

The great increase of production of nitric acid, as well as sulphuric acid, of high strength, is due to the demand for the manufacture of modern explosives. At Griesheim, pure and strong nitric acid is made by condensing in a receiver kept at 80° C., beyond which is a reflux condenser; the more volatile impurities, including the lower oxides of nitrogen, are carried on.

A description is given, with a figure, of the improved form of revolving iron cylinder adopted by the Solvay firm for the heating of bicarbonate of soda made by the ammonia process in order to convert it into the normal carbonate, a regulated amount of the latter, from a previous operation, being mixed in with the new material to be treated.

The facts are quoted with interest in respect to the natural carbonate of soda held in solution by the water of Owens Lake, in Inyo County, California. Chatard's report estimating the total amount of this carbonate in the lake at 40 to 50 millions of tons; the product, so far obtained in a small way only, has the composition $Na_2CO_3.NaHCO_3.H_2O$, but can, of course, be converted into the normal carbonate by heating.

There is an account of Castner's new industrial product, sodium dioxide, likely to prove a valuable laboratory reagent, which is made, chiefly for use in bleaching, by the Aluminum Company (Limited), of London and Oldbury; prepared by heating metallic sodium to 300° C. in vessels of aluminum, and passing over it at first air nearly deprived of oxygen, and at the end of the process air containing its full proportion of oxygen. The product is best applied in bleaching along with magnesium sulphate, so as to avoid the ill effects of the alkaline soda if unneutralized.

An interesting result is presented of the reduced demand for metallic sodium, due to aluminum being now made by electrolysis, in the application of the former metal to the manufacture of a mixed potassium and sodium cyanide (sold as "cyanide of potassium" for use in the metallurgy of gold) by the reaction

$$K_4Fe(CN)_6 + Na_2 = Fe + 4KCN + 2NaCN,$$

which, unlike the older processes, avoids the formation of cyanate and utilizes the whole of the cyanogen present.

Under the head of "Produits chimiques et pharmaceutiques" are included all the finer chemicals, especially those of organic character. There is a passing remark on the difficulty in distinguishing at Chicago, in the American department, between products really made in the United States and those which American houses sent to the exhibition, although acting only as importers or agents for European firms.

The great activity shown of late years in the production of new medicinal agents, and in the investigation of their physiological effects, is commented upon, and a long list is presented of these substances, partly of natural origin, extracted from vegetable sources—new alkaloids, glucosides, etc.—and partly prepared by synthetic laboratory methods. The enormous increase in the production of quinine, followed by a fall in price from 800 to 1,000 francs per kilogramme thirty years ago to 30 or 40 francs now, is noted, and the occurrence at the Chicago exhibition of fine specimens of cupreine, the alkaloid from Remigia pedunculata, of which the relation to quinine has been shown by Grimaux and Arnaud, quinine being methyl-cupreine. Sparteine, now applied to medical use, and gymnemic acid, from the leaves of Gymnema sylvestris, with its curious effect upon the nerves of taste, rendering them insensible to the impressions of bitter or sweet, are among the newer substances of natural origin which are mentioned. As regards chloroform, notice is taken of the now general practice of first independently preparing chloral and then decomposing it by an alkali, and also of the Pictet method of purifying chloroform by crystallizing it on exposure to very low temperature (the melting point is −62° C.) But nothing is said as to the extensive substitution of acetone for alcohol as the prime material. Among the synthetic products for medical use are noticed diethylene-diamine (piperazine) as a solvent for uric acid, and paraphenetol-carbamide (sucrol) as a sweetening material when sugar is to be avoided.

Attention is drawn to the extension and growing importance of photographic chemicals, and of those used as reagents in scientific laboratories and in analysis. There has been marked improvement of late years in the variety of these attainable, and in the purity of condition which many of them present as they can now be purchased.

Interesting little specialties are noted in the "artificial spindle oil" exhibited by the Russian firm of Krestovnikoff Brothers, of Kasan, an oleate of amyl, and the "lipogenine" of the same firm, a palmito-stearate of ethyl. These products suggest a comparatively little trodden path, the investigation of the various esters and other salts of the higher fatty acids, artificially produced. A step in the industrial application of such work was taken a number of years ago, when the Aktien-Gesellschaft fur Anilinfabrikation, of Berlin, began to make their Anilinfettfarben for color printing, salts of linoleic, etc., acids with the colored triamine bases, rosaniline, etc.

The report contains an extended discussion of the structure of the principal artificial coloring materials used in modern dyeing, and of the difficult question of general relation between structure and tinctorial properties, the reporter adopting provisionally Witt's classification of these materials in 17 groups. Reference is made, for the general history of this department of chemical industry, to Caro's admirable lecture before the German Chemical Society in 1892. The exhibition of coal tar colors was not by any means so extensive and brilliant at Chicago as at several places at which previous expositions had been held; it is noted that there were but three European firms producing these colors represented, out of about thirty such firms in existence and at work. Among the newer materials of this kind are particularly noticed new anthracene blues, producing very fast tints on wool, which resist exposure to air, light, and washing with soap, fully replacing indigo in wool dyeing; indoine, a derivative of pheno-safranine, giving good results resembling those of indigo on cotton; and some valuable new rhodamines. There was a fine display of artificial indigotine and of the various materials which are required for its synthesis by different lines of approach.

Under the head of materials for perfumery it is remarked that France is still, as she has long been, the leading producer of natural perfumes of vegetable origin, but that of late years the cultivation of flowers, etc., for this use has been extended from the French Mediterranean coast to that of Algeria, where there are now large plantations under exceedingly favorable conditions as respects climate. The only essential oil mentioned as produced in the United States is that of mint; no notice is taken of other American specialties, such as sassafras and wintergreen (gaultheria). There is a decided advance reported in the production of artificial or synthetic perfumes—the isolation of irone, as the odorous principle of the iris and the violet, and the extraction from oil of lemon of citral, from which (itself a substance of but moderate cost) can be produced synthetically ionine, isomeric with irone, and having

* French Official Report on Chemical Industry at the Chicago Exhibition. M. Haller. Rapport du Comite 19; Produits chimiques et pharmaceutiques, materiel de la peinture, parfumerie, savonnerie. Paris, 1894.—From the American Chemical Journal.

the same iris and violet odor—the production of aubepine (anisic aldehyde), neroline and yara-yara from β-naphthol, etc.

The report is sent out from the "Imprimerie Nationale," and illustrates the clearness and elegance of French typography. J. W. M.

[Continued from SUPPLEMENT, No. 1012, p. 16177.]

THE CAUSE OF LUMINOSITY IN THE FLAMES OF HYDROCARBON GASES.*

By PROF. VIVIAN B. LEWES.

Effect of Diluents upon Acetylene.—If it is the decomposition of the molecule of acetylene which develops the heat which is the cause of the incandescence of the carbon particles, then, if acetylene could be burned without decomposition, a non-luminous flame should be produced. It is conceivable that this might be done by so diluting the acetylene that it would require a much higher temperature to break it up.

It was Heumann who showed (Liebig's Ann., vol. clxxxiii., pt. I) that hydrocarbon gases may burn with luminous flames, i. e., with separation of carbon in the flame, or with non-luminous flames, i. e., without any separation of carbon, and that the maintenance of a high temperature is an essential condition of luminosity—a flame the temperature of which has been lowered by any means being no longer able to bring about the required separation of carbon. He also points out that "combustible matter, when diluted with indifferent gases, requires to be maintained at a higher temperature, in order that it may burn with a luminous flame, than when it is undiluted with such gases."

Dr. Percy Frankland, in his researches on the effect of diluents upon the illuminating value of hydrocarbons, showed that ethylene, which was capable of developing a light of 68·5 candle power when burned by itself, became non-luminous when diluted with about

Hydrogen	90	per cent.
Carbon monoxide	80	"
Carbon dioxide	60	"
Nitrogen	87	"

Results which will show that excessive dilution by inert gases destroys luminosity. (Chem. Soc. Jour., vol. xlv.)

In order to see if dilution had the same effect upon acetylene, experiments were made by diluting it with pure hydrogen. The gases were mixed over water, the proportion of acetylene actually present in the gas being determined by analysis at the burner. Although the water in both holder and meter was, as far as possible, saturated with the gas, yet, as the analyses show, this precaution was an important one.

Composition of Mixture. Made in Holder.		Composition of Mixture. At Burner.		Illuminating Value of Mixture per 5 c. c. when Burned in 00 Bray.
Hydrogen.	Acetylene.	Hydrogen.	Acetylene.	
90	10	90·5	9·5	nil
80	20	81·5	18·5	1·8
70	30	65·5	34·5	14·0
50	50	43·5	56·5	87·0

This shows that dilution with between 80 and 90 per cent. of hydrogen rendered the acetylene non-luminous when the mixture was burned from a burner suitable for the higher values of gas.

In order to determine the point at which luminosity was destroyed when consuming the mixture in a burner suited to develop the light from a gas of low illuminating power, the experiment was repeated, using a 3-inch flame burning from the London Argand, and also from a No. 4 Bray union jet, the latter being employed because it is difficult to determine the temperature in the Argand flame.

Analysis of Mixture. Hydrogen.	Acetylene.	Illuminating Value per 5 Cubic Feet. Argand.	No. 4. Bray.
92	8	Not measurable.	
91	9	Not measurable.	
88·5	14·5	4·1	1·7

So that luminosity would be destroyed in the Argand by dilution with about 90 per cent. hydrogen and in the No. 4 Bray with about 88 per cent.

The next point to be determined was whether the destruction of luminosity in the diluted acetylene flame was in reality due to dilution, rendering it necessary to employ a higher temperature for the decomposition of the acetylene, or to other causes.

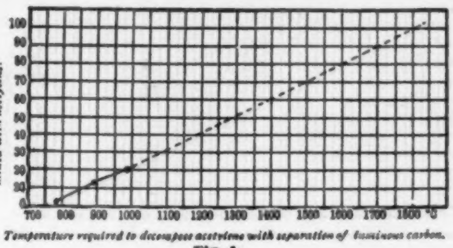
In order to do this a tube made of specially infusible glass 4 mm. in diameter was taken, and the Le Chatelier thermo-couple was fitted into it in the same way as before, used with the platinum tube. All air having been rinsed out by a current of the mixture to be experimented with, the gas was allowed to pass at a steady rate of flow through the tube, the point at which the thermo-couple was situated being steadily heated by the Fletcher blowpipe, while the temperature recorded on the scale was noted the moment that incandescent liberation of carbon commenced.

Percentage Composition of Gas. Acetylene.	Hydrogen.	Temperature Necessary to Cause Deposition of Carbon with Luminosity.
100	0	780° C.
90	10	896° C.
80	20	1,000° C.

It was found impossible to obtain a glass tube which would stand temperatures higher than this; but on plotting out the points so obtained, and which give a fairly straight line, it is seen that even if the increase in temperature only continues for increased dilution, in the same ratio as shown in the experimental determination, which is extremely unlikely, the reason of the destruction of luminosity in highly diluted hydrocarbon gases is at once explained, as an increase of each 10 per cent. in the dilution would necessitate an increase of 100° C. in the temperature of the flame, and with 90 per cent. dilution a temperature of over 1,700° C. would be required to bring about decomposition.

My reason for believing that it is highly improbable that when dilution is great it only requires the same increment in temperature to bring about decomposition as when the dilution is small, is that in all the work I have done on the effect of diluents upon luminosity, and also in Professor Percy Frankland's researches upon the same subject, dilution with hydrogen and carbon monoxide acts regularly, and decreases the value of the illuminant in a direct ratio down to about 50 per cent., while when the degree of dilution exceeds 60 per cent. a rapid falling away in the luminosity takes place; a fact which, I think, points clearly to a regular pro rata rise of temperature being needed for increase in dilution up to between 50 and 60 per cent., while higher degrees of dilution need a far greater rise of temperature in order to bring about decomposition.

Moreover, it would be manifestly incorrect to look upon the percentage of acetylene present in the gas issuing from the burner as being any guide to the degree of dilution existing at the point at which luminosity commences.



Temperature required to decompose acetylene with separation of luminous carbon.

FIG. 1.

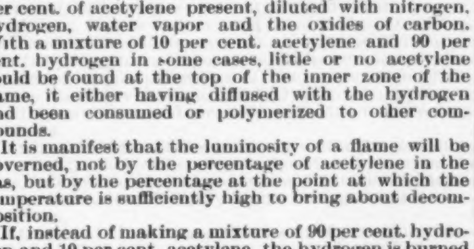
As the two small streams of gas issuing from the holes in the union jet meet and splay themselves out into the flat flame, they draw in with them a considerable proportion of air, the quantity being governed by the pressure of the gas at the burner. This can be clearly seen by the fact that a high value gas which burns from a union jet burner of a given size with a smoky flame, under a gas pressure of half an inch of water, will burn with a bright, smokeless and rigid flame, of greatly increased illuminating value, when the pressure is raised to 2 inches, while an ordinary coal gas of 16 candle value must be burned from a flat flame burner at a pressure of about 0·75 inch if the best results are to be obtained, the increase in air drawn in, if the pressure rises to a much higher degree, diminishing the illuminating value.

Then, again, the area of non-luminous combustion in a mixture of gases like coal gas means that some at least of the hydrocarbons are consumed before the required temperature for their decomposition is reached, while the products of combustion formed in the lower part of the flame are mixed with the flame gases, partly by diffusion and partly by being drawn into it by the upward rush.

When a simple hydrocarbon like ethylene or acetylene is burned alone, the whole of the heat required to bring about the decomposition has to be generated by the combustion, without decomposition, of a considerable proportion of the hydrocarbon, and this means considerable dilution at the spot where the luminosity commences, so that at the top of the non-luminous zone of an acetylene flame there is only some 14 or 15 per cent. of acetylene present, diluted with nitrogen, hydrogen, water vapor and the oxides of carbon. With a mixture of 10 per cent. acetylene and 90 per cent. hydrogen in some cases, little or no acetylene could be found at the top of the inner zone of the flame, it either having diffused with the hydrogen and been consumed or polymerized to other compounds.

It is manifest that the luminosity of a flame will be governed, not by the percentage of acetylene in the gas, but by the percentage at the point at which the temperature is sufficiently high to bring about decomposition.

If, instead of making a mixture of 90 per cent. hydrogen and 10 per cent. acetylene, the hydrogen is burned at the end of an open platinum tube which has a fine platinum tube passing up the center to the top of the inner zone of the flame, and if the acetylene be passed into the flame at the rate of one volume for every ten of the hydrogen, not only do we obtain an intensely luminous, but a very smoky flame. In this experiment the gases were issuing from their respective tubes at the same pressure, but the small tube soon choked from deposited carbon, and it was found that the same results could be equally well attained by drawing



Candle power calculated to a consumption of 5 cubic feet per hour.

FIG. 2.

down the inner tube to the level of the hydrogen tube, and making the acetylene issue at a slightly higher rate of flow, which hurried it in a compact stream through the inner zone of the hydrogen flame.

In order to see if the percentage of acetylene present at the top of the non-luminous zone bore any ratio to the illuminating value of the mixture, experiments were made in which mixtures of hydrogen and acetylene were burned at a small flat flame burner, and the percentage of acetylene was determined by gently aspirating out some of the flame gases from the top of the non-luminous zone.

Analysis of Mixture Used. Hydrogen.	Acetylene.	Acetylene at Top of Non-luminous Zone.	Illuminating Value of Flame for 5 Cubic Feet.
65·5	34·5	3·72	14·0
43·5	56·5	8·42	87·0
0·0	100·0	14·95	240·0

On plotting out these results, they certainly seem to point to the fact that, with flames of the same size burning from the same burner, the light emitted by the flame is directly proportioned to the percentage of acetylene present at the top of the non-luminous zone of the flame, provided always that the temperature is sufficiently high to complete the decomposition of the acetylene.

It is perfectly possible for the temperature of a flame to be so little above the point necessary to decompose the diluted acetylene that, while some decomposes and renders the flame faintly luminous, the larger portion burns without decomposition. A good example of this is to be found in the combustion of alcohol, the flame of which contains as much acetylene as is to be found in a good coal gas flame, but which is practically almost non-luminous. If alcohol be ignited in a small dish, it burns with a faintly luminous flame, and if a bell jar is placed over it, some of the products of combustion mingling with the flame still further cool it and render it non-luminous; but if now a stream of oxygen be introduced under the bell jar, the temperature is at once increased and the flame becomes highly luminous, while a cold porcelain vessel held in the flame is coated with soot.

In all the experiments in which light was developed in heated tubes by the decomposition of acetylene, the glow of the carbon was red and lurid, the light emitted being of the same character and appearance as that developed by the combustion of potassium in carbon dioxide, and entirely lacking the pure white incandescence of the acetylene flame as burned from a flat flame burner.

This may be due to the fact that in the open flame the temperature of the carbon particles is, presumably, due to three sources of heat:

A. Heat derived from the decomposition of the acetylene molecule.

B. Heat derived from the combustion of hydrogen, carbon monoxide, and some hydrocarbons in the flame.

C. Heat derived from the combustion of the carbon particles themselves.

In the tube experiments the heat of the walls of the tube and the heat of decomposition alone are acting; and it is evident that the intensity of the heat finding its way through the walls of the tube will be very different to that exercised by the walls of burning gas which inclose the luminous portion of the flame. There can be but little doubt that the temperature of the carbon particles will vary enormously with the rate at which the acetylene decomposes, as the more quickly the action take place the greater will be the localizing action upon the heat evolved, and the higher the incandescence of the carbon particles. That this is so seems certain from the whiteness of the flash of light emitted when the acetylene is detonated.

Endothermicity and Combustion Heat.—Experiments were made in order to, if possible, gain an idea as to how much of the incandescence of the carbon particles was due to the endothermicity of the decomposing acetylene, and how much to the action of heat and combustion on the carbon particles after formation. In order to do this a non-luminous flat flame of large size was desired, and was obtained by using coal gas de-illuminated by slowly passing it through bromine, well washing with sodic hydrate solution and water, and then passing it through strong sulphuric acid, the gas so treated having an illuminating value of 1·2 candle for 5 cubic feet when burned in the London argand at such a rate as to give a 3-inch flame, while in a fish-tail burner it gave a non luminous flame.

This gas gave, on analysis, the following percentage composition:

Carbon dioxide	0·00
Unsaturated hydrocarbons	0·00
Carbon monoxide	5·50
Saturated hydrocarbons	33·28
Hydrogen	55·25
Nitrogen	5·49
Oxygen	0·48
	100·00

So that its combustion would give practically the same temperature and flame reactions as those in an ordinary gas flame.

A very fine platinum tube was now obtained, closed at one end, and with five minute holes bored in a line close to the sealed end. This having been so arranged that the holes were buried in the flame just at the top of the inner zone, acetylene was allowed to flow gently through them into the flame. At the points where the acetylene issued into a flame small areas of intense luminosity were produced, while the liberated carbon streaming up between the flame walls of the upper zone produced dull red bands of very low luminosity. It may be suggested that the carbon particles supplied in this way to the flame may have agglomerated and formed masses larger than those produced in the ordinary way, but I do not think that was the case, as the particles were completely consumed and no smoke escaped from the crown of the flame, whereas, if a flat flame is interfered with in such a way as to cause the carbon particles to roll themselves together, smoking of the flame is produced.

I think the inference to be drawn from this experiment undoubtedly is that it is the heat of decomposition which gives the high incandescence and light-emitting value to the carbon particles, and that the temperature of the combustion of the other flame gases, and, finally, of the carbon itself, plays but a secondary part.

Cyanogen Analogy Considered.—In considering these results, it seems remarkable, if acetylene owes its power of rendering hydrocarbon flames luminous to its high endothermic properties, that cyanogen, which is still more endothermic, should burn under all conditions that have at present been tried with a non-luminous flame:

		Heat of Formation.
Acetylene	C_2H_2	—47,770
Cyanogen	C_2N_2	—65,700

It is clear that if the rapidity of decomposition localizes the heat evolved to the products of decomposition, and that renders the liberated carbon particles incandescent, while the hydrogen plays at best a very subsidiary part, it ought not to matter whether it be hydrogen or nitrogen which is combined with the carbon.

Berthelot showed that cyanogen, like acetylene, could be detonated by a small charge of mercuric fulminate, but he notes that the test is not always suc-

* Communicated to the Royal Society.

cessful; which points to the decomposition of this body requiring a greater expenditure of energy to break up the molecule than is the case with acetylene. And known facts would lead us to expect that this would be the case, as although exothermic compounds become less and less stable with rise of temperature, endothermic bodies, on the other hand, become more stable, and the endothermicity of cyanogen being greater than that of acetylene, would lead one to expect that temperatures which would decompose acetylene would have no effect on cyanogen, and that as, during the combustion of cyanogen, the liberation of nitrogen would probably have a diluting and cooling action, the cyanogen would burn directly without liberating any carbon which would emit light.

In order to see if the temperature of the cyanogen flame, when burned from an ordinary flat flame burner, differed much from that of hydrocarbons when consumed in a flame of the same size and kind, the temperatures were experimentally determined by the same method and in the same parts of the flame as had before been employed with acetylene, ethylene and coal gas.

Portion of the Flame.	Temperature.
Center of inner zone.	1.377° C.
Top of inner zone	2.085° C.
Near top of outer zone	1,645° C.

This shows that the cyanogen flame was actually hotter than the acetylene and ethylene flames, and about the same as the coal gas flame, but that the heat was differently distributed, the inner zone being far hotter than in the other gases, while the maximum temperature of the flame was at the apex of the inner zone instead of being near the top of the flame.

An experiment was now made to ascertain if it was possible to decompose cyanogen with luminous deposition of carbon by passing it through a hard glass tube, heated by means of the blowpipe; but at the highest temperature attainable no trace of any deposition of carbon was found, showing how far more stable cyanogen is under the influence of high temperatures than acetylene.

The structure and characteristic appearance of the cyanogen flame have been explained by Smithells (Chemical Society Journal, 1891) and Dent, who conclude that the inner zone of peach blossom tint is caused by the combustion of the cyanogen to carbon monoxide and nitrogen, while the outer blue cone is formed by the oxidation of the monoxide to dioxide; the green fringe to the outer cone being attributed to the presence of small quantities of oxides of nitrogen. If this explanation be accepted, it is clear that we could not obtain luminosity in the portion of the flame immediately above the inner zone, as all cyanogen has been destroyed without decomposition before that point is reached. It is conceivable, however, although no luminosity can be detected in a cyanogen flame, and although the temperature which can be obtained in a glass tube is insufficient to break up the compound with luminous separation of carbon, that if cyanogen could be heated to a considerably higher temperature, it might be possible to decompose it in such a way as to develop luminosity.

In order to try this point, a hydrogen flame was burned from the end of an open platinum tube 9 mm. in diameter, and a thin platinum tube 2·5 mm. in diameter was passed through the broad tube to the apex of the inner zone, and a slow stream of cyanogen was admitted, with the result that the flame at once became luminous; and on surrounding the hydrogen flame with an atmosphere of oxygen, to increase the temperature, the luminosity was considerably increased.

This experiment at once explains the cause of the non-luminosity of the cyanogen flame. It shows that it is purely a question of temperature; and the probabilities are that, burned in a flame which gave sufficient heat to rapidly decompose it, nearly as high an illuminating value as that of acetylene would be obtained from cyanogen.

I think the explanation of the apparent anomaly of the cyanogen flame having a higher temperature than the acetylene and ethylene flames is to be found in the fact that the molecules of cyanogen are consumed without previous decomposition, so that the heat absorbed during the formation of cyanogen is added to the heat of combustion and raises the average temperature of the flame, whereas with acetylene the instantaneous decomposition of the molecule before combustion confines the heat evolved to the liberated products, and the average temperature of the flame is but little more than the heat of combustion.

Ratio between Illuminating Value and Heat of Formation.—If the luminosity of a hydrocarbon flame is principally due to the localization, during intensely rapid decomposition, of the heat of formation in the products, the illuminating values of such hydrocarbon gases as contain 2 atoms of carbon in the molecule should bear a simple ratio to their heat of formation. The gaseous hydrocarbons are:

Hydrocarbon.	Composition.	Heat of Formation at Constant Pressure.
Ethane	C_2H_6	+25,670
Ethylene	C_2H_4	− 8,000
Acetylene	C_2H_2	−47,770

And although they may undergo many changes in the flame, they will all ultimately be reduced to carbon and hydrogen again before the full luminosity of the flame is developed.

When the acetylene into which these hydrocarbons is converted by heat is decomposed, the action takes place with such enormous rapidity that one would expect the heat evolved to simply divide itself among the liberated atoms, so that the question of specific heat at high temperatures may be omitted.

With exothermic compounds like ethane, considerable heat will have to be developed by its own combustion before it is converted into the acetylene which, by its decomposition, endows the flame with luminosity, and if we take the ethane and call its light-producing energy 1, we can then obtain a ratio of such energy for the other hydrocarbons available for distribution among the products of decomposition.

$$\text{Ethane} \ldots\ldots \frac{25{,}670}{25{,}670} = 1$$

$$\text{Ethylene} \ldots\ldots \frac{25{,}670 + 8{,}000}{25{,}670} = 1{\cdot}31$$

$$\text{Acetylene} \ldots\ldots \frac{25{,}670 + 47{,}770}{25{,}670} = 2{\cdot}86$$

These ratios must now be divided among the atoms liberated from the molecule at the moment of decomposition, and we thus obtain the ratio:

$$\begin{array}{ccccc} C_2H_6 & & C_2H_4 & & C_2H_2 \\ \dfrac{1}{8} & : & \dfrac{1{\cdot}31}{6} & : & \dfrac{2{\cdot}86}{4} \\ \text{or } 1 & : & 1{\cdot}74 & : & 5{\cdot}72 \end{array}$$

The determination of the illuminating value of a gas becomes more and more difficult the higher its illuminating value, owing to the cooling effect of the small burners that must, of necessity, be used in order to insure complete combustion. Dr. Percy Frankland (Chem. Soc. Jour., vol. xlvii) assigned the illuminating value of 35 candles to ethane, as the mean of four tests which varied considerably among themselves. Adopting his figure, the calculated illuminating values for the ethane, ethylene and acetylene would be:

	Illuminating Value. Calculated.	Found.
Ethane	1×35= 35	35
Ethylene	1·79×35= 60·9	68·5
Acetylene	5·72×35=200·2	240

These figures are far nearer the experimental ones than could have been expected, considering the crude character of the calculation and insufficient data, which leads to omitting altogether such important factors as the amount of gas consumed to bring about the requisite temperature of decomposition, the specific heat of the products, and the thermal value of the change from gaseous to solid carbon; and they are of no value except as showing that a ratio does exist between heat of formation and illuminating value.

Methane is the only other gaseous hydrocarbon of which the heat of formation is known, it being + 21,750. As the molecule contains only 1 atom of carbon, 2 molecules have to be taken, and on calculating the probable illuminating value by the same method as was applied to the other hydrocarbons, we should have:

$$\frac{\dfrac{25{,}670 + \{25{,}670 - (21{,}750 \times 2)\}}{25{,}670} \times 35}{10 \times \frac{1}{8}} = 8{\cdot}4$$

The illuminating value as determined by Mr. Lewis T. Wright is 5·2; but here, again, we know by experiment that methane requires a very high temperature to bring about its conversion into acetylene and decomposition into carbon and hydrogen, and that to do this a large portion of the gas must be burned without decomposition.

Deductions.—The facts which I have sought to establish in this paper are:

1. That the luminosity of hydrocarbon flames is principally due to the localization of the heat of formation of acetylene in the carbon and hydrogen produced by its decomposition.

2. That such localization is produced by the rapidity of its decomposition, which varies with the temperature of the flame and the degree of dilution of the acetylene.

3. That the average temperature of the flame due to combustion would not be sufficient to produce the incandescence of the carbon particles within the flame.

In my paper on the action of heat upon ethylene, brought before the Royal Society this spring, I showed that the decomposition of ethylene into acetylene and simpler hydrocarbons was mainly due to the action of radiant heat, and was but little retarded by dilution, while I have shown in this paper that the acetylene so produced requires a considerable increase in temperature to bring about its decomposition when diluted.

It is possible with these data to give a fairly complete description of the actions which endow hydrocarbon flames with the power of emitting light. When the hydrocarbon gas leaves the jet at which it is being burned, those portions which come in contact with the air are consumed and form a wall of flame, which surrounds the issuing gas. The unburned gas, in its passage through the lower heated area of the flame, undergoes a number of chemical changes, brought about by the action of radiant heat emitted by the flame walls, the principal of which is the conversion of the hydrocarbons into acetylene, methane and hydrogen. The temperature of the flame quickly rises as the distance from the jet increases, and a portion of the flame is soon reached at which the heat is sufficiently intense to decompose the acetylene with a rapidity almost akin to detonation, and the heat of its formation, localized by the rapidity of its decomposition, raises the liberated carbon particles to incandescence, this giving the principal part of the luminosity to the flame; while these particles, heated by the combustion of the flame gases, still continue to glow, until finally themselves consumed, this external heating and final combustion adding slightly to the light emitted. Any unsaturated hydrocarbons which have escaped conversion into acetylene before luminosity commences, and also any methane which may be present on passing into the higher temperatures of the luminous zone, become converted there into acetylene, and being at once decomposed to carbon and hydrogen, increase the area of the light giving portion of the flame.

My thanks are due to Mr. F. B. Grundy for the help he has given me in the work entailed by this paper.

A NEW MICRO-ORGANISM DISCOVERED IN PORK.

By FRANK J. THORNBURY, M.D., Buffalo, N. Y.

IN my work as microscopist in the Bureau of Animal Industry, I have commonly observed in various parts of the muscular system of swine, undergoing inspection with reference to the presence of trichine, a peculiar fungus. This fungus presented itself in the form of bundles of threads which have various colors and are intermingled with the muscle fibers, or found separate in a clump under the field of the microscope.

Out of 1,000 hogs inspected daily at the government abattoir, Buffalo, I have found fifty, on an average, to be infected by this organism.

The parts of the carcass from which samples are taken for the trichinous inspection are the diaphragm, neck and loin respectively; hence these were the parts in which I have usually found the fungus. As corroborated by Prof. Miller, of Berlin, this organism belongs to the saccharomyces or yeast group. It has very distinctive morphological characteristics and I here present for your inspection pure cultures in every media which we have at our disposal. At a later time I will detail the peculiarities of growth of this organism in the various media and give the results of my experiments upon animals. The former are particularly interesting and present contrast in many respects to any organism with which we have thus far had to deal. This can only be a brief outline of my contribution. I direct your notice to drawings of different culture tubes made by Mr. F. C. Busch. They are very accurate and serve to give you an impression of the luxuriant manner in which the organism thrives in artificial media, and of the coloration which it produces. I will later show you photo-micrographs, produced by Dr. Hill, and will have their duplicates thrown upon the screen for more detailed inspection. A pathogenic potency of this fungus—saccharomyces porcus—is shown by the destruction of white mice and rats twenty-four hours after inoculation. I have recovered the organism from the blood of these animals, which is found to be heavily laden.—Buffalo Med. and Surg. Jour.

THE OUNCE OR SNOW PANTHER.

SINCE the end of last year, the menagerie of the Museum of Natural History, of Paris, has for the first time been in possession of a magnificent panther, indigenous to Central Asia, and very different from the ordinary panthers of India and Africa. This panther, whose arrival the newspapers prematurely announced in designating the animal as the "white panther," is the species popularly known as the ounce and scientifically as the Felis irbis. The museum owes it to the generosity of Prince A. Gagarine, secretary of the Russian embassy at Bokhara, and to the intervention of Mr. E Blanc, the well known explorer of Central Asia, who kindly used his influence to secure for the Jardin des Plantes an animal that had never been seen but once in the zoological gardens of Western Europe. At the request of Prince Gagarine, whose acquaintance had been made by Mr. Milne Edwards at the Zoological Congress of Moscow in 1891, and whom he had a chance to see again at Paris, Baron Wrewsky, governor general of Turkestan, had an ounce captured in the mountains of Pamir and carried to Tachkent, where Prince Gagarine took possession of it. From Tachkent the animal was taken by wagon to Bokhara by Prince Gagarine himself, who at once wrote to Mr. Blanc to announce to him the arrival of the valuable specimen. This was at the end of August, 1894, the animal being then eighteen months old. Having been notified by Mr. Blanc, the director of the museum at once telegraphed his thanks to Prince Gagarine and wrote to the French consuls at Tiflis and Baku in order to secure their assistance in the transmission to France of the host so impatiently awaited by the Jardin des Plantes. Unfortunately, things did not move as quickly as was desired. Difficulties were thrown in the way by the Russian Railway Company of Central Asia, and on the 10th of October the panther had not yet left Bokhara. Prince Gagarine then decided to have it accompanied as far as to Baku, and entirely at his own expense, by a trustworthy man who put it into the hands of the French consul, Mr. Dubail. The latter accompanied the animal from Baku to Batoum, upon the Black Sea, and there shipped it upon La Bourdonnais, which carried it to Marseilles, whence it was sent by rail to Paris.

Such is the history of the snow panther of the Jardin des Plantes, of which we have now to point out the zoological characters. Let us say at once that it does not merit the name by which several papers have designated it, viz., that of "white panther." It differs from the true panthers by a high skull, strongly convex in its anterior part, by its abruptly rising forehead, its short and wide face, its prominent superciliary arcades, its middlingly developed canines in the upper jaw, its small and obtuse ears and its eyes with rounded pupils. Its tail, which is much more tufted than that of an ordinary panther, is regularly cylindrical and reaches nearly the length of the body. In adult individuals, such as the one under consideration, the tail measures about 36 inches, the total length of the animal being 4 feet. The fur, which is very thick, as befits that of an animal of cold countries, is not of a pure white, except upon the belly. Everywhere else its fundamental color is yellowish or grayish white, with here and there bluish reflections of extreme delicacy. Upon this ground color are scattered black spots of diverse forms, some very sharply outlined, and others blending insensibly at the edges with the ground color. The tail is marked with numerous interrupted rings. The fore and hind quarters are marked with transverse spots, while upon the back and flanks are seen large and irregularly traced rosettes more or less shaded off at the edges and surrounding small tinted spaces. A dark stripe follows the backbone, and, finally, upon the forehead and cheeks there are arranged in regular series a few black lines and spots that replace the parallel lines of the other felines.

There is considerable variation in the shade and markings of the ounce, however. Thus, according to the traveler Siebold, Mr. D. G. Elliott has mentioned a specimen of this species that came from Corea and in which the coat was of a beautiful fawn color widely and strongly spotted with black, that is to say, much more brilliantly colored than the coat of the ounce now living in the Jardin des Plantes. On the contrary, the pale tints of this latter had already been noticed in a skin received by the museum from the frontiers of Persia and more recently in some skins brought home by Prince Henry d'Orleans from his voyage to Thibet. All these skins were what are called in commerce "flet," that is to say, deprived of bony head and some-

times even mutilated at the extremity of the limbs. Even in this state, the skin of the ounce is greatly in demand among furriers, because of the softness of their tints and the abundance of their hair, and their serving for the manufacture of magnificent floor rugs and rich lap robes for sleighs and carriages. So with us they bring a very high price. In Thibet, on the contrary, they can be obtained at more reasonable figures, and Prince Henry d'Orleans has seen them sold there at the rate of from two to four rupees apiece.

It is not to be wondered at that the old naturalists, having before their eyes incomplete skins only, obtained through the channels of trade, and without any precise data as to the place whence derived, should not have been able to get a clear idea of the zoological characters and the geographical distribution of the ounce. Thus, Buffon, while giving quite a satisfactory description of the animal's fur, has certainly confounded the ounce with the guepard, since he claims that the ounce is never met with in the countries of the north, nor even in temperate regions, but is very common in Barbary, Arabia and Southern Asia, where it is trained for hunting. It is the guepard, in fact, and not the ounce that is employed as an auxiliary in hunting the gazelle, and it is it that is found both in the southwest of Asia and over a large portion of the African continent. The ounce, on the contrary, is an exclusively Asiatic carnivore, which, far from seeking warm climates, delights in the frozen plains of Turkestan and Thibet and in the Himalayan chain, and which ascends sometimes to an altitude of 18,000 feet, thus crossing the limit of eternal snow. By its mode of life it therefore fully justifies its name of "snow panther" that the English naturalists sometimes give it.

The ounce is also found in the north of Persia and in Asia Minor, and in the western provinces of China, in the basin of the river Amoor, in Corea and in the island of Sakhalien. Upon the whole the area of habitat of the species extends over a long strip to the north of the Himalayas, from the Sea of Japan and the Sea of Okhotsk as far as to the Mediterranean. At certain points of this vast region ounces must be quite numerous, and yet it has been said that they are everywhere very rare. This is due to the fact that they avoid the vicinity of man, whom they never attack. Thus, the English traveler Wilson asserts that in twenty years' hunting in the Himalayas he has never been able to see more than a dozen snow panthers, although he has certainly passed within range of a hundred of these carnivores, which must have observed him from their lurking places in the thickets. The Goldes, who dwell near the north of the Amoor, hardly know the ounce by sight, for the reason that they have formed a terrible idea of it. They call it the jerga, and dread it still more than they do the tiger; and the Giliaks, their neighbors of the maritime province of Siberia and of Sakhalien Island, do not distinguish these animals from each other. This error is explained up to a certain point by the fact that the tiger of Mongolia and Siberia is provided, like the ounce, with thick fur and differs from the tiger of Bengal by its much paler color and by the less distinct stripes of its coat. However timid it be ordinarily, the ounce becomes singularly bold when its appetite is excited. Thus, Wilson has heard it said that a snow panther prowling around a flock of sheep will allow itself to be pelted with stones for an entire night rather than leave the place. Mr. Elliot, who narrates this fact in his monograph of the Felidæ, gives still another trait of the boldness of two animals of the same species. "One day," says he, "a Mr. Danford, while hunting in the mountains near Smyrna, killed a wild goat, which fell upon a rock. In order to get it he had to make a detour that took him a dozen minutes, and when he reached the point where the animal had been lying a few minutes previous, he found nothing but a handful of hair and a pool of blood. The goat had disappeared, but the recent tracks of two ounces upon the snow clearly showed who were the ravishers."

Wild goats of various species, several sorts of wild sheep, and especially those called burrals in the Himalayas, domestic goats and sheep, chickens, gazelles and marmots are the animals upon which the snow panther feeds in a wild state. Upon looking at the individual now in the Jardin des Plantes, one would scarcely say that the species to which it belongs had so sanguinary instincts. This individual, in fact, appears to be very gentle, and when a living rabbit was given it for the first time, it was quite a long time before it touched it. It must be said that it was kept tied up for several weeks by its first master, Prince Gagarine, who partially tamed it. At Bokhara the animal was fed upon butcher's meat and upon milk, which it drank with avidity, but showed, on the contrary, a certain repugnance to water. Upon its arrival at the museum it was desired to treat it like the other felines, and it was at first taken indoors at night; but, since it appeared to suffer from the heat and confinement, it was decided to allow it to sleep in an open cage with no other protection than a dog kennel, even during the coldest weather. This new regimen suits it perfectly and, more fortunate than many a boarder in our menagerie, it has nothing to fear from the severity of the winter through which we are passing.

For our engraving and the above details we are indebted to La Nature.

THE OUNCE OR SNOW PANTHER.

[Continued from SUPPLEMENT, No. 1012, page 16179.]

THE SAN JOSE SCALE.*

(Aspidiotus perniciosus Comstock.)

By Prof. C. V. RILEY.

MODE OF SPREADING.

IT follows, from what has already been stated of this and other allied species of scale insects, that of their own accord they can spread but a very short distance annually. Indeed, it is a question whether the insect could ever spread from tree to tree wherever the trees are some distance apart, and the branches do not interlock, were it not for other agencies which aid them. The principal methods by which these insects are carried from one tree to another and from one place to another, while yet in the newly hatched larva condition, are (1) by the agency of wind, (2) that of running water, (3) by being carried upon the feet or feathers and hair of birds or other animals, and (4) particularly by means of flying and crawling insects and gossamer spiders which frequent the same trees. In this connection I quote the following from my last report as United States Entomologist:

"Some interesting observations were made by Mr. Schwarz upon the transporting of the young Coccid larvæ by other insects. This very Pentilia was, unconsciously, an active agent in this dangerous work. Hardly one of the beetles could be found which did not carry on its back at least one Aspidiotus larva, and sometimes three or four were found upon a single wing cover of a beetle. A small black ant (Monomorium minutum) was abundant upon the pears, attracted by the juice emerging from the cracks, and almost every one of these ants carried on its back one or more specimens of the Coccid larvæ. Specimens of a little Chrysomelid beetle (Typophorus canellus) were also found upon the trees. Red and black specimens of these beetles occurred, and the interesting observation was made that while the Aspidiotus larvæ crawled freely upon the black individuals, no specimens were to be found upon the red ones. This same peculiar fact was also found to hold with the ants, since the red ant (Formica schaufussi) was abundant upon the pears, but no specimens were found bearing Aspidiotus larvæ, while, as just stated, the little black Monomorium was always found carrying specimens. Curiously enough, no ladybirds other than Pentilia were seen. The common twice-stabbed ladybird (Chilocorus bivulnerus), which is so active an enemy of scale insects and plant lice throughout the Southern States, was absent."

The scale insects are, however, primarily carried to long distances, while shielded by the scales, through the instrumentality of man, upon scions and nursery stock. The agency of wind has frequently been noted in the more rapid spread of the insects in the direction of prevailing winds. This agency is not only direct, wherever the wind is sufficiently strong, as in severe storms passing over infested districts at the right season, but it is also indirect in that the flight of insects bearing the young scale insects is also influenced thereby. The young scale insect is not easily dislodged from the twig or branch of a tree, but there is every reason for believing that when the tree is very badly infested, so that the scales are literally piled one upon another, the young lice, finding no means of support thereon, more readily attach themselves to the bodies of other creatures or deliberately let themselves drop, to be carried by wind or by running water, this last means being much more effective in aiding their spread in countries which are dependent on artifical water supply, and where irrigating ditches run near or through the orchards.

As already indicated, it has been proved to have been introduced from California on nursery stock at Parryville, N. J., and there are probably other centers of infection, like that in Missouri, from which the insect has been brought directly from California. It would be unjust, however, to charge the nurserymen with the sole responsibility of this distribution, because there is every reason to believe that it has been introduced into other localities upon fruit, the rejected rind or peel of which, carrying the insect, has been thrown out of car windows or from houses. This conclusion is justified by the frequency with which the insect has been found in our large Eastern markets, upon fruit, especially pears.

PREVENTIVE MEASURES.

It is obvious from what has preceded that most of the influences at work in helping the insect to spread are essentially local, and would hardly cause it to overrun a State for very many years to come. Yet through man's instrumentality, there is constant danger of importation from infested regions long distances away, either upon fruit or nursery stock. It is, as a consequence, very desirable and necessary that every fruit grower in the State whose trees are now free from the attacks of this pest should be on his guard against such introduction. No fruit should be brought on from an open market without first being inspected, and no buds, scions or trees from any nursery should be received without a similar first careful inspection.

THE GAS TREATMENT.

This treatment consists in enveloping the tree in an airtight tent and afterward filling the tent with hydrocyanic acid gas, generated from fused potassium cyanide, sulphuric acid and water. This gas is much lighter than air and as soon as generated rapidly rises and fills the tent.

The tent is usually constructed in the form of an octagonal sheet of what is ordinarily known as 8 ounce duck, and is afterward oiled with boiled linseed oil. A tent of this kind, measuring 40 feet in diameter, will cost about $50, and other sizes in like proportion.

Almost any glazed earthenware vessel will answer the purpose of a generator. The potassium cyanide used is usually of 60 per cent. strength and the sulphuric acid is of the ordinary commercial brand. The proportions are: 1 ounce, by weight, of cyanide, 1 fluid ounce of the acid and 3 fluid ounces of water. This is sufficient for 150 cubic feet of space inclosed by the tent.

The water is first placed in the generator, the acid added, and after the generator is placed under the tent, the cyanide is added to the solution. The cost of the chemicals mentioned is small. The tree is subjected to the action of the gas for about half an hour. In treating trees 10 feet high or less, the tent can be placed over the tree by hand, but for those of greater height than this some sort of apparatus must be used for the purpose of elevating the tent over the tree. An apparatus in the form of a tripod, with a pulley at the top, serves this purpose very well.

The best results will be obtained by treating the trees during the colder portion of the year or at night, as the gas is more liable to injure the trees when used in very warm weather than it is when the weather is cooler.

The very poisonous character of the potassium cya-

* Abstracted from advance copy of Bulletin No. 32, Maryland Agricultural Experiment Station.

nide itself and of the hydrocyanic acid gas must be strongly impressed upon those who undertake to use this treatment for the first time.

Judging from the experiments at Charlottesville, Va., under the auspices of Mr. Coquillett, and from those which were conducted so extensively in Montserrat on limes, even this gas treatment fails to destroy all the eggs where the insects are at all thickly crowded on the tree, so that a single fumigation can hardly be depended upon to be perfectly effective in extermination. I learn also from Mr. Howard that the pear trees seem to have materially suffered in the cracking of the bark, as a consequence of this gas treatment.

SUMMER AND WINTER WASHES.

The different insecticides vary in their efficacy according to climatic and other conditions, and there is yet a wide field for careful experimentation bearing on these differences.

It is evident, from the irregular and continuous production of the young of the San Jose scale during the summer months, that the summer washes, useful if repeated with sufficient frequency, can hardly be depended upon to exterminate the insect or entirely rid the tree affected with it. The necessity of their frequent use makes them also more expensive. Any treatment that will be effective by one application is preferable, especially if this can be applied in the dead of the year, when other horticultural operations do not command so much time. Hence our chief reliance must be on what are known as winter washes, or on the gas treatment already described.

The lime, salt and sulphur wash which is used with so much satisfaction against this insect in California proved much less satisfactory in a series of experiments which I had made during the winter of 1893-94, both on the department grounds on other species of armored scales and on my own place at Sunbury. The experiments were made on American and Japanese Euonymus affected by Chionaspis euonymi as also on a hedge of Japanese quince affected by the common scurvy scale, Chionaspis furfurus. The resin washes were also found in experiments upon the same insects to be less effectual than they are in California.

The results since obtained at the Department of Agriculture give a very high relative value to the ordinary commercial whale oil soap, applied at the rate of two pounds or more to the gallon of water, and next to this the resin wash used five or six times stronger than indicated in the ordinary formula. My own more recent experience this winter confirms the efficacy of the strong whale oil soap solution. Unfortunately, both these washes are expensive, but in this, as in so many other things, the best, even if the most expensive, is the cheapest in the end, and where trees have already become infested by this pernicious insect they will be very likely to succumb in the end, unless some remedial measures are taken or unless some special efforts are made to introduce and encourage the parasites and natural enemies already treated of.

Insecticide Apparatus.—A good, strong double-acting force pump should be purchased and mounted on a large stout barrel with the supply tube reaching well down to the bottom. It has become the custom to mount the pump in the end of the barrel, but except in the case of the Nixon tripod, it will be almost as easy to mount it on the side of the barrel, which is easily held in place by a skid near either end, and is then more compact and stable than when standing on the end, while the handle of the pump comes lower and is more easily worked.

It will be well to buy the pump without the attachments. About 25 feet of ¼ inch cloth insertion rubber tubing is attached to the discharge orifice, or to each of the orifices in case there are two. To the end of the tube is fitted one of the modifications of the Cyclone or Riley nozzle and the outer 8 or 10 feet are clamped or wired to a light pole or bamboo fishing rod for convenience in elevating the nozzle into the larger trees. The tank or barrel is mounted on a cart or sled and driven between the tree rows, one man driving and pumping and the other holding and directing the extension pole and nozzle.

I have mentioned the Cyclone nozzle for the reason that, all things considered, I believe it, in some of its modifications, to be the best for orchard work. The Climax nozzle manufactured and sold by the Nixon Nozzle and Machine Company is also a good nozzle, but it is rather large and clumsy, its spray hardly so fine, and it will not answer for fungicides containing lime, since it clogs easily. The Vermorel modification of the Cyclone nozzle possesses a little attachment which quickly unclogs the orifice when once stopped up, and is therefore preferable. Moreover, neither the Cyclone nor the Vermorel modification is patented, which, other things being equal, is in their favor. Both are manufactured by Thomas Somerville & Sons, Washington, D. C., and Robert Leitch & Sons, also of Washington, or may be made by any brass and iron worker from the descriptions in my official reports.

For application to nursery stock or to smaller trees one of the smaller hand pumps advertised by various manufacturers, especially pump makers, as hydronets or aquapults, will answer the purpose, though better still would be the use of what are known as knapsack pumps. The price of these ranges from $10 to $20.

IMPORTANCE OF THE MATTER: FINAL ADVICE.

It is very doubtful whether the fruit growers of the Eastern States have yet awakened to a realization of the importance of taking active measures to stamp out, if possible, this pernicious scale insect, or at least to protect from it trees not yet affected. It has been introduced within comparatively few years, and there is, therefore, an excellent chance of restricting its range, or of ridding particular orchards of it. Professor J. B. Smith, entomologist of the New Jersey Experiment Station, has issued a special bulletin upon the insect, which is more widely distributed in that State than elsewhere in the East and which, in fact, as we have already seen, has been largely distributed to other parts from that State. He closes his bulletin with a series of recommendations which have been very widely circulated and even copied in the official bulletins of other States, and which, though excellent in themselves, are, I fear, rather calculated to discourage those who have extensive orchards to disinfect. The chief of these recommendations are as follows:

First. Every orchard that has been set out within the last six years should be thoroughly examined to ascertain whether or not the scale is present.

Second. If it proves to be present and is confined to a few trees, the trees had better be taken out and destroyed, unless the infestation is so slight that the trees can be gone over with a stiff brush and all the scales actually brushed off.

Third. If the orchard is young, and the trees are not too large to be handled, it will be best to use a stiff brush and, taking each tree separately, brush off all the scales. This looks like a good deal of mechanical work; but it will pay in the end. It can be done at any time during the winter; it will be absolutely effective and, with care, there need be no further trouble from this insect in an orchard so treated.

Fourth. If the trees are too numerous to be treated by hand, or are too large to be conveniently handled, prune back liberally, removing as much wood as the tree can easily spare. The cuttings should be carted off and burnt as a matter of precaution, and what remains of the trees should be washed with the potash solution above described. This should be done as soon as may be, and a month later, during a moderately mild spell, the trees should be again treated, this time with the kerosene emulsion, made as above described and diluted five times. The object of this double treatment is, first, by means of the potash to dissolve or corrode the scales to a great or less extent, and to kill off a considerable proportion of the insects themselves. At the end of a month the potash will probably have been washed down and all dissolved away, so as to exert no further action. The scales, however, will be thinned down, riddled or loosened from their hold, and an application of the kerosene emulsion then made will give it abundant opportunity to reach the insect. If both these materials are applied thoroughly, the kerosene will finish any work left undone by the potash and not a single specimen need escape.

I have serious doubts whether anything is to be gained by the stiff brush treatment urged by Professor Smith, involving, as it does, an infinite amount of labor and the severe pruning of larger trees which it involves, since crushing off the scales is impracticable on the smaller twigs and branches. Any winter wash that is effective will obviate the necessity for this preliminary labor.

The other treatment recommended is most valuable, but requires two sprayings, viz., one of the potash solution and one of the kerosene emulsion. As a result of later experiments the past winter, as set forth in this bulletin, it becomes evident that any thorough spraying of the two pound to the gallon solution of the whale oil soap will be perfectly effective, and may be depended upon as a substitute for the treatment urged by Professor Smith. Cost of materials and convenience in obtaining will, otherwise, influence each individual in the choice of the comparatively few satisfactory winter washes, as indicated in this paper, and whether the saving of labor by the method here recommended will offset the increased cost of material, as compared with Professor Smith's method, must be left for each to decide.

JAMES DWIGHT DANA.*

James Dwight Dana, Professor of Geology and Mineralogy in Yale College and for fifty years one of the editors of this Journal, died suddenly at his residence in New Haven, Connecticut, April 14, 1895, at the age of eighty-two years and two months.

He was born in Utica, New York, February 12, 1813. His father, James Dana, was of New England birth, having moved to Utica from his parents' home in Massachusetts. He was a successful business man and died in 1860 at the age of eighty. His mother was Harriet Dwight, daughter of Seth Dwight, of Williamsburg, Massachusetts.

The strong inborn taste for science was shown in early years, and he was fond of relating his pleasant experiences at the Bartlett Academy in Utica, when as a boy of twelve he studied chemistry with his associates, sharing with them the responsibility of preparing the experiments and delivering to the others the formal lectures. At the same time, frequent excursions after minerals with his companions served to give a special direction to his scientific interests and thus helped to determine the department in which his first work was to be done when maturity had developed his powers. These excursions were led by Mr. Fay Edgerton, the excellent instructor in natural science, and extended to distant parts of the State and also to neighboring States; one excursion into Vermont was remembered with much delight.

To the opportunities afforded by the early training in science, that have been alluded to, and to the interest it excited, Professor Dana ascribed much of the success that he afterward attained. One of his schoolmates, closely associated with him in the Bartlett Academy, was S. Wells Williams, for many years missionary in China and in his later life again a colleague among the corps of instructors at New Haven. A number of others, who subsequently rose to prominence, were among those who shared the inspiration of Mr. Edgerton's instruction. It is also of interest that Dr. Asa Gray, a close friend from early days, took Mr. Edgerton's place in the school in 1831.

In 1830, attracted by the name and reputation of Professor Silliman, he came to New Haven and entered the class of 1833 of Yale College, then in its Sophomore year. He was a faithful student, but those were days of a rigid course of study, chiefly in the classics, affording little to appeal to a mind with a strong bent for the methods and facts of science. It is not surprising, therefore, that though obtaining a good place on the honor list, he did not make a brilliant record for general scholarship. He was, moreover, at a disadvantage because of insufficient training in the ancient languages, felt especially by one entering after the close of the first year of the course. It should be stated, however, that during his undergraduate life, he attained distinction in mathematics, a subject for which he always had decided aptitude. During this time he made much progress in science, especially in his favorite study of Mineralogy. In Botany also he took great interest; during his college life he made a large collection of the plants of the New Haven region, and a printed list of the local flora, carefully checked and annotated by him, is still preserved.

For music he had throughout his life a strong love, and when in college he devoted much attention to it, being on one occasion president of the Beethoven singing society, and for a time the leader of the college choir. He also made some attempts at musical composition. One of these was the music for an ode to the ship Peacock of the Exploring Expedition, written by the surgeon, Dr. J. C. Palmer; both gentlemen found a source of recreation and pleasure in their joint musical and poetical work during the voyage. It is interesting to note that many years later when upward of seventy and unable because of ill health to write, he came back to his music and derived much comfort from working at it.

The influence of the elder Silliman, then at the height of his powers and reputation, did much to decide him to devote himself permanently to science, as will be seen in the events that followed. It is a point of interest also, as proving how deep his natural love of science was, that from home he obtained no encouragement whatever in turning his studies in this direction; indeed, from the time of graduation he assumed the entire burden of his own support. To his father's practical mind scientific pursuits did not commend themselves, but it should be stated that he lived to take a cordial interest and pride in his son's success.

Mr. Dana left New Haven in August, 1833, somewhat in advance of graduation, to avail himself of the opportunity offered of a cruise in the Mediterranean, as instructor in mathematics to the midshipmen of the United States navy. In this capacity he visited a number of the seaports of France, Italy, Greece and Turkey, while on the Delaware and the United States. This trip, lasting about fifteen months, brought much pleasure and profit. He was cut off for a time from his favorite minerals, but he occupied his leisure hours on shipboard with working out, by methods of his own, many of the more intricate problems of mathematical crystallography. Some notes of the voyage also mention the fact that he was interested in the study of the geology of the island of Minorca and that he made some collections in natural history while there. It will be observed that the first paper recorded in the Bibliography, which follows this notice, is an account of the condition of Vesuvius in July, 1834, at the time of his visit; this was published in this Journal in 1835.

In 1836, Mr. Dana returned to New Haven and for two years remained there, occupied for more than a year as assistant in chemistry to Professor Silliman. It was during this period that he published his first important contribution to science—the System of Mineralogy, a volume of 580 pages. This was in May, 1837, hardly four years after his graduation from college and when a young man of twenty-four; notwithstanding his youth, the work is that of a thoroughly mature and well informed scholar. A little earlier (1835) his notes mention the fact that he had constructed a set of crystallographic models in glass, probably the first time this had been attempted.

While at New Haven, another opportunity came to him for travel and observation, this time as mineralogist and geologist to the exploring expedition then about to be sent by the government of the United States to the Southern and Pacific Oceans under the command of Commodore Charles Wilkes. The invitation, when first received in 1836, was refused, but on the urgent solicitation of Dr. Asa Gray, then expecting to go as botanist, the decision was reconsidered and finally the position accepted. He was disappointed in failing to have the companionship promised, but subsequent events brought the two men closely together, and Dr. Gray remained an intimate personal friend and highly valued scientific associate until his death in 1888.

The expedition, consisting of five ships, sailed in August, 1838, and Mr. Dana was connected with it until June, 1842. The route was briefly as follows: First to Madeira, then to Rio Janeiro, down the coast and through the Straits of Magellan, after passing which, while on board the Relief he nearly suffered shipwreck off Noir Island, the ship remaining three days and nights in extreme peril; in the same storm one of the smaller accompanying vessels was lost. Then to Chile, Peru and across to the Paumotus, to Tahiti and the Navigator Islands; then to New South Wales, where the naturalist remained while Commodore Wilkes went into the Antarctic; then to New Zealand, the Fiji Islands, where two of the officers were murdered by the natives; to the Sandwich Islands, the Kingsmill group, the Caroline Islands and thence north to the coast of Oregon. Here, near the mouth of the Columbia River, the Peacock, the ship to which he had been assigned, was wrecked, entailing the loss of all his personal effects as well as many of his collections. He was then one of the party that crossed the mountains near Mt. Shasta and made their way down the Sacramento River to San Francisco. In his report of the expedition he states that the geological features indicated the probable presence of gold. This was six years before the discovery of gold in California, and rich mines have since been discovered in the region the party went over. At San Francisco the party were taken aboard the Vincennes and the homeward journey was made by way of the Sandwich Islands, Singapore, the Cape of Good Hope and St. Helena. The arrival in New York was on June 10, 1842.

The opportunities of this long journey to many of the most interesting points in the world were such as have been offered to few young men of his years and could never come again. The stimulus of the multitude of new facts to observe and of new forms of life to collect and study was extraordinary, and the effect of these four years upon the attainments of his subsequent life was profound. Of the beauties of the life in the sea about the coral islands and of that of the tropics in general he never tired of speaking; his lecture on "Coral Islands," delivered in later years to many generations of college students, contained a vivid description of the scenes he enjoyed so much.*

It is interesting to note here that, a few years before the American expedition was in the Pacific, the British ship Beagle, having the naturalist Darwin on board, had sailed through much of the same region.

* From the American Journal of Science.

* This subject is presented in somewhat popular form in the work entitled "Corals and Coral Islands," first published in 1872.

The theory explaining the formation of the coral atoll by gradual subsidence, first advanced by Darwin (1842), was also independently worked out to a large extent by the American naturalist.* The latter showed, moreover, that the reef-building corals lived only in water of at least 68° Fahr., which proved that the distribution of corals depended on the temperature of the water.

As already stated, Mr. Dana was first appointed in the field of Geology, and his observations and deductions are given in a large quarto volume of 756 pages, with a folio atlas of 21 plates (1849). Later, however, in part because of the return of one his colleagues to the United States, he assumed charge also of the Crustacea and Zoophytes. These combined departments gave full scope to his zeal and industry. The results of his work in this department of zoology include a Report on Zoophytes, a quarto volume of 741 pages, with a folio atlas of 61 plates (1846); also a Report on Crustacea, in two quarto volumes, aggregating 1,620 pages (1853) and accompanied by a folio atlas of 96 plates (1854). These three reports will be more particularly spoken of later, but it may be mentioned here that a large part of the drawings of the plates in both works was made by his own hand.

In June, 1842, Mr. Dana returned to the United States and for the next thirteen years devoted his chief energies to the study of the material collected on the expedition and to the preparation of the reports mentioned. His labors, however, were not limited to this field, for during the same period he prepared and issued three editions of the System of Mineralogy (1844, 1850, 1854) and two editions of the Manual of Mineralogy (1848, 1857), besides writing numerous papers for this and other scientific periodicals.

From 1842 to 1844 he resided in Washington, and later in New Haven. On June 5, 1844, he married Miss Henrietta Frances, third daughter of Professor Benjamin Silliman, whose assistant he had been in 1836–37, and with whom he was from this time closely associated in scientific work.

The labor on the material from the exploring expedition was carried forward with the enthusiastic zeal of an earnest student with a new world open before him, and who was but little restrained by the thought that injury to health was possible. How severe and intense the labor of this period was will be evident from the fact that a few years after the last report was published, Mr. Dana's health broke down, and so completely that, though he lived thirty-five years after this and accomplished a wonderful amount of scientific work, life was from this time ever a struggle, and not always with success, against physical disability.

In 1846 Mr. Dana was made an editor of this Journal, associated with Professor Benjamin Silliman, who had founded it twenty-eight years before, and with his son, Professor Benjamin Silliman, Jr. His labors in connection with the Journal continued until the close of his life.

In 1850, Mr. Dana was appointed Professor of Natural History in Yale College, and in 1864 the title was changed to that of Professor of Geology and Mineralogy. His duties as instructor, however, he did not take up until 1855, but, after this date, with some interruptions due to ill health, as more particularly noted later, his active connection with the college continued until 1890. It is perhaps interesting to add that just before his appointment to Yale in 1850, he had been invited to a similar position at Cambridge, Massachusetts, in connection with Harvard College, but by the prompt action of a generous friend in the Yale faculty in providing the necessary funds, he was induced to remain in New Haven on the "Silliman Professorship." This gentleman, who is still living, remained throughout the life of Mr. Dana one of his closest friends.

In 1859, as already noted, long-continued overwork brought a breakdown of a serious character and from which he never fully recovered. The nervous prostration was very complete at first, and even a period of nearly a year abroad, from October, 1859, to August, 1860, seemed to have little result in the way of restoration. Although later some degree of health gradually came back, he was always subject to the severest limitations until the end of his life. Only those immediately associated with him could appreciate the inexorable character of these limitations and the self-denial that was involved not only in restricting work and mental effort, but also in avoiding intercourse with other men of science and friends in general, in which he always found the greatest pleasure.

Little by little the power for work was restored and by husbanding his strength so much was accomplished that, besides other writing, he was able to bring out in 1862 the first edition of his Manual of Geology, and in 1864 the Text Book of Geology, and four years later his last and most important contribution to mineralogy, the fifth edition of the System.

This last great labor, extending over four years, was followed by a turn of ill health of an alarming character and from which restoration was again very slow. The years that immediately followed were filled with the same quiet labor, on geological investigations in the field, the writing of original papers and books, the editorial work of this Journal, and his duties as a college instructor. They were remarkably productive years, notwithstanding the difficulties contended against, notably renewed illness in 1874 and 1880, as will be seen by reference to the Bibliography. A large number of important papers were published, chiefly in this Journal: New editions of the Manual of Geology were issued in 1874 and 1880; of the Text Book in 1874 and 1883; while a new geological volume called "The Geological Story Briefly Told," was issued in 1875, and one on "Corals and Coral Islands" in 1872.

The years from 1887 to 1890 include the time when he most nearly threw off the limitations of ill health. In the summer of 1887, accompanied by his wife and youngest daughter, he revisited the Sandwich Islands, the acquaintance of which he first made in 1840, when on the exploring expedition. This was, indeed, the first long journey made except that to Europe in search of health in the years of 1859–60, since the expedition returned in 1842. He was led to make this journey † because of the interest aroused in discussing the phenomena connected with the eruption of the volcano of Kilauea on the island of Hawaii. The journey brought the keenest pleasure, not only that due to revisiting the Sandwich Islands themselves, but also that of making the acquaintance of a number of interesting places in the western United States. Though travel had ordinarily been too severe a tax since his health gave out, this journey of ten weeks, extending over 10,000 miles, proved of profit, and every incident was entered into with the enthusiasm of a mind which years could not make old. A number of papers upon the Hawaiian volcanoes were the result of this summer's outing, and in the winter of 1889–90 he prepared a volume on Volcanoes, a companion to that on Corals and Coral Islands, a new edition of which was issued at the same time. The prefaces of both works were dated on his seventy-eighth birthday, February 12, 1890.

In the summer of 1889 he attended the meeting of the American Association at Toronto, the first time he had been present at such a meeting since he delivered the presidential address more than thirty years before.

With the autumn of 1890 came a more serious illness than any since 1859, and the indications seemed very alarming. For a number of months absolutely no work was done, and later only a little light labor by means of dictation. It was at this time that the small volume on the New Haven region, entitled "The Four Rocks," was given to the public. This disability was again partially thrown off—although he never again resumed active college duty—and the work on the fourth edition of the Manual of Geology, then far advanced, was resumed slowly at first and then with more vigor with returning strength. From this time, however, till the end he seldom exceeded a limit of three hours' labor each day.

In February, 1893, the printers began their work on the volume mentioned, and it was just two years before the last proof had been read and the volume was complete. To himself and still more to those about him it seemed many times as if the completion of this great work would have to be left to others, but with the self-control born of a strong will and long experience, and with the never-failing watchful care of his lifelong companion—without which his labors could never have been so productive nor have been continued so long—he worked on slowly, doing each day only what he had strength for, and, finally, the labor was accomplished. The completion of this work, which was rewritten and rearranged from beginning to end, involving a critical consideration of the many new facts and theories of the science, will be granted to have been a remarkable performance for a man of eighty-two. He finished it in February, 1895, and a month later he had completed the manuscript of a new edition of his Geological Story and then commenced work on that of the Text Book.

On Saturday, April 13, he took his usual excursion to the post office, and through the day was as bright and vigorous of mind as ever. That evening there was a recurrence of a slight trouble in the action of the heart, of which there had been some manifestations in the few months immediately preceding; the following day he did not rise, although feeling relieved; in the evening the trouble returned, and after a very brief period of unconsciousness, he passed quietly away.

The concluding years were marked by an ever-increasing serenity, and happiness in his work and in the friends about him. Up to the last day there was no evidence of diminished mental force, though his physical strength was somewhat impaired. It was for him a most happy ending of a life full of fruitful activity and honor.

* A brief discussion of thi theory is given on a later page of this number (p. 436); it was one of the last subjects on which he wrote.

† See this Journal, vol. xxxiv, 319, November, 1887.

THE GOLD BELT OF CALIFORNIA.*

By H. W. TURNER.

THE gold belt of California includes that portion of the Sierra Nevada lying between the parallels of 37° 30′ and 40°. This area is bounded on the east by the great basin and on the west by the great valley of California, comprising about 17,000 square miles. The Sierra Nevada here forms a single range, sloping somewhat abruptly toward the great basin and gradually toward the great valley of California. Within this area lie the chief gold deposits of the State, though by no means all of the area is auriferous. At the northern limit the deposits are scattered over nearly the entire width of the range, while to the south the productive region narrows to small dimensions. The mass of the range south of Alpine County is comparatively barren. North of the 40th parallel the range is probably not without deposits, but the country is flooded with lavas which effectually bury them.

The rocks of the Sierra Nevada are of many kinds and occur in very complex associations. They have been formed in part by deposition beneath the sea, and in part by intrusion as igneous masses, as well as by eruption from volcanoes, and portions of them have been subsequently metamorphosed.

The southern portion of the range is composed of granite. The central and northern part, west of longitude 120° 30′, consists prevailingly of schists, which have been produced by intense metamorphism of both ancient sediments and igneous rocks, and it is chiefly but not solely in these schists that the auriferous quartz veins occur. The trend of the bands of altered sediments and of the schistose structure is generally from northwest to southeast, parallel to the trend of the range, but great masses of granite and other igneous rocks have been intruded among these schists, forming irregular bodies which interrupt the regular structure and which are generally bordered each by a zone of greater metamorphism. These schists, with their associated igneous masses, form the older of two great groups of rocks recognized in the Sierra Nevada. This group is generally called the bedrock series.

Along the western base of the Sierra occur beds of sandstone and clay, some of which contain thin coal seams. These are much younger than the mass of the range and have not shared the metamorphism of the older rocks. They dip gently westward beneath the later deposits, which were spread in the waters of a shallow bay occupying the valley of California and portions of which have been buried beneath recent river alluvium.

* From the Geologic Atlas of the United States.

Streams flowing down the western slope of the Sierra in the past distributed another formation of great importance—the auriferous gravels. The valleys of these streams served also as channels for the descent of lavas which poured out from volcanoes near the summit. Occupying the valleys, the lavas buried the gold-bearing gravels and forced the streams to seek new channels. These have been worn down below the levels of the old valleys, and the lava beds, with the gravels which they protect, have been isolated on the summits of ridges. Thus the auriferous gravels are preserved in association with lavas along lines which descend from northeast toward southwest, across the trend of the range. The nearly horizontal strata, together with the auriferous gravels and later lavas, constitute the second group of rocks recognized in the Sierra Nevada. Compared with the first group—the bedrock series—these may be called the superjacent series.

The history of the Sierra Nevada, even so far as it is recorded in the rocks, has not yet been fully made out, but the events of certain epochs are recognized, and these may be stated in a brief summary in the order in which they occurred.

THE PALEOZOIC ERA.

During the Paleozoic era, which includes the periods from the end of the Algonkian to the end of the Carboniferous, the State of Nevada west of longitude 117° 30′ appears to have been dry land of unknown elevation. This land probably extended westward into the present State of California and included part of the area now occupied by the Sierra Nevada. Its western shore was apparently somewhat west of the present crest, and the sea extending westward received Paleozoic sediments which now constitute a large part of the central portion of the range.

At the close of the Carboniferous the Paleozoic land area of western Nevada subsided, and during a portion or all of the Juratrias period it was at least partly covered by the sea. At the close of the Juratrias, according to the latest paleontological determinations, the Sierra Nevada was upheaved as a great mountain range, the disturbance being accompanied by the intrusion of large amounts of granite.

The auriferous slate series comprises all of the sedimentary rocks that entered into the composition of this old range of Juratrias time. Formations representing the Algonkian and all of the Paleozoic and Juratrias may therefore form part of the auriferous slate series.

Fossils of Carboniferous age have been found in a number of places, and the presence of Silurian beds at the northeast base of the range has been determined. A conglomerate occurs in the foothills of Amador and Calaveras Counties, interbedded with slates containing carboniferous limestone; this conglomerate is therefore presumably of Carboniferous age. The conglomerate is evidence of a shore, since it contains pebbles of quartzite, diabase, and hornblende porphyrite, which have been rounded by the action of waves. The presence of igneous pebbles in the conglomerate shows that volcanic eruptions began at a very early date in the formation of the range, for the hornblende porphyrite pebbles represent lavas similar to the hornblende andesites of later age.

The Paleozoic sediments of the gold belt consist of quartzite, mica schist and clay slate, with limestone lenses. Rounded crinoid stems, Lithostrotion, Fusulina, Clisiophyllum, Spirifera, and other genera have been found, chiefly in the limestone, and indicate that the age of the rocks is Carboniferous. The Paleozoic sediments are finely exposed in Calaveras County, and on the gold belt sheets they will be designated the Calaveras formation. It is probable that some areas mapped as Calaveras may contain strata earlier or later than the Carboniferous.

During an epoch of upheaval some time after the close of the Carboniferous period, these sedimentary strata were raised, forming part of a mountain range. The beds were folded and compressed, and thus rendered schistose. Granite and other igneous rocks were intruded among them, and they assumed somewhat the relations which they now exhibit in the Sierra Nevada. But those masses which now form the surface were then deeply buried in the foundations of the range. They have been brought to the present surface by subsequent uplifts and prolonged erosion.

JURATRIAS PERIOD.

The areas of land and sea which existed during the earlier part of this period are scarcely known. Strata showing the former presence of the sea have been recognized in the southeastern portion of the range at Mineral King, where the sediments are embedded in eruptive granite, and at Sailor Canyon, a tributary of American River. Rocks of this age occur generally throughout the great basin and the Rocky Mountains, but the interior sea or archipelago in which they were deposited was apparently separated from the Pacific by a land mass stretching the length of the Sierra Nevada. This land probably originated in the upheaval above referred to, some time after the close of the Carboniferous, and toward the end of the Juratrias period its area became so extensive that the waters of the Pacific seem to have been completely separated from the interior seas. This conclusion is based upon the fact that fossils of Jurassic age in California, so far as known, have closer relations with those of Russia than with those of eastern America.

The genus Aucella, whose shells occur in Russia, flourish on the Pacific coast until well into the Cretaceous, and is distributed from Alaska to Mexico. In the Juratrias strata of California it is associated with ammonites of the genera Perisphinctes, Cardioceras and Amaltheus, which are closely related to forms of the European Upper Jurassic.

The strata in which these fossils occur are prevailingly clay slates, which are locally sandy and contain pebbles of rocks from the Calaveras formation. Thus it is evident that they were deposited near the shore of a land composed of more ancient schists, and the generally fine character of the sediment shows that the land which occupied the area of the Sierra Nevada cannot have been very mountainous. These strata now occur in two narrow bands along the western base of the range, and are called the Mariposa formation, from the fact that they are well exposed near Mariposa.

Soon after the Mariposa formation had been deposited

the region underwent uplift and compression. The result of uplift was the development of a mountain range along the line of the Sierra Nevada. The coast range also was probably raised at this time. The action of the forces was such as to turn the Mariposa strata into a vertical position, shattering the rock and deforming it, and producing some metamorphism. The clay shales now have a slaty structure, produced by pressure, which appears to coincide in most cases with the bedding. It was a time of intense eruptive activity. The Mariposa beds were injected with granite, and vast masses of diabase, associated with other basic igneous rocks, date from this time. There is evidence that igneous rocks were intruded in varying quantities at different times, but that the intrusion of the great mass of the igneous rocks accompanied or immediately followed the upheavals is reasonably certain.

The Mariposa beds carry numerous gold veins, the most important group of which constitutes the famous "Mother lode." It is believed that most of the gold veins were formed after this upheaval, and, as a consequence of it, occupying fissures opened during the uplift.

The disturbance following the deposition of the Mariposa beds was the last of the movements which produced the vertical arrangement of the auriferous slate series. The strata of succeeding epochs are sediments and tuffs. Lying nearly horizontal or at low angles, they prove that since they were accumulated the rock mass of the Sierra Nevada has not undergone much compression. But the fact that they now occur high above sea level is evidence that the range has undergone elevation in more recent time.

CRETACEOUS PERIOD.

By the close of the Juratrias the interior sea of North America had receded from the eastern base of the Sierra Nevada eastward beyond the Rocky Mountains. From the western part of the continent the waters of the Pacific had retired in consequence of the Juratrias uplift. The valley of California was then partly under water, and the coast ranges seem to have been represented by a group of islands, but during the later Cretaceous the region subsided and the sea substantially overflowed it. Through gradual changes of level the areas of deposition of marine sediments were shifted during the Cretaceous and Neocene periods, and late in the Neocene the sea once more retreated west of the coast ranges. The deposits laid down during this last occupation of the valley of California belong to the superjacent series.

The advance of the sea spread a conglomerate over the eastern part of the valley in later Cretaceous time, and sandstone and shale were subsequently deposited. This formation is well developed near Chico, and at Folsom, on the Sacramento sheet. It has been called the Chico formation.

EOCENE PERIOD.

In consequence of slow changes of level without marked disturbance of the Chico formation, a later deposit formed, differing from it somewhat in extent and character. The formation has been called the Tejon (Tay-hone). It appears in the gold belt region at the Marysville Buttes, and it is extensively developed in the southern and western portions of the valley of California.

NEOCENE PERIOD.

The Miocene and Pliocene ages, forming the later part of the Tertiary era, have in this atlas been united under the name of the Neocene period. During the whole of the Neocene the great valley of California seems to have been under water, forming a gulf connected with the sea by one or more sounds across the coast ranges. Along the eastern side of this gulf was deposited during the earlier part of the Neocene period a series of clays and sands to which the name Ione formation has been given. It follows the Tejon, and appears to have been laid down in sensible conformity to it. Marine deposits of the age of the Ione formation are known within the gold belt only in the Marysville Buttes. Along the eastern shore of the gulf the Sierra Nevada, at least south of the 40th parallel, during the whole of the Neocene, and probably also during the Eocene and latest Cretaceous, formed a land area drained by numerous rivers. The shore line at its highest position was several hundred feet above the present level of the sea, but it may have fluctuated somewhat during the Neocene period. The Ione formation appears along the shore line as blackish water deposits of clays and sands, and frequently it contains beds of lignite.

The drainage system during the Neocene had its sources near the modern crest of the range, but the channels by no means coincided with those of the present time. The auriferous gravels for the most part accumulated in the beds of these Tertiary rivers, the gold being derived from the croppings of veins. Such gravels could accumulate only where the slope of the channel and the volume of water were sufficient to remove the silt while allowing the coarser or heavier masses to sink to the bottom with the gold.

The climate of the late Neocene was warm and humid, much moister than it would have been if the great valley had been above water, and erosion was correspondingly rapid.

A mountain-building disturbance occurred during the Neocene period. This was caused by pressure acting from the SSW. toward the NNE. with a downward inclination. One effect of this pressure was to induce movements on a network of fissures, often of striking regularity, intersecting large portions of the range. It is not improbable that this fissure system originated at this time, but there are fissures of greater age. This disturbance also initiated an epoch of volcanic activity accompanied by floods of lavas* consisting of rhyolite, andesite and basalt, which continued to the end of the Neocene. These lavas occupy small and scattered areas to the south, increasing in volume to the north until, north of the 40th parallel, they cover almost the entire country. They were extruded mainly along the crest of the range, and often followed fissures belonging to the system mentioned above. The recurrent movements on the fissures were probably accompanied by an increase in the development of the fissure system. An addition to the gold deposits of the range attended this period of volcanic activity.

When the lavas burst out they flowed down the river channels. Sometimes they were not sufficient to fill the streams, and are now represented by layers of "pipe clay" or similar beds in the gravels. These minor flows were chiefly rhyolite. The later andesitic and basalt eruptions were of great volume, and for the most part completely choked the channels into which they flowed. The rivers were thus obliged to seek new channels—substantially those in which they now flow.

Fossil leaves have been found in the pipe clay and in other fine sediments at numerous points. Magnolias, laurels, figs, poplars and oaks are represented. The general facies of the flora is thought to indicate a low elevation, and has been compared with that of the flora of the South Atlantic coast of to day.

PLEISTOCENE PERIOD.

During Cretaceous and Tertiary time the older Sierra Nevada had been reduced by erosion to a range with gentle slopes. An elevation of the range doubtless attended the Neocene disturbance above referred to, and minor dislocations probably recurred at intervals; but at the close of the Tertiary a greater uplift occurred, which was accompanied by the formation of normal faults. These were widely distributed throughout the range, particularly along the eastern escarpment, where they form a well marked zone to the west of Mono Lake and Owen Lake. As a consequence of this elevation, the streams having greater fall cut new and deep canyons in the hard but shattered base of the pre-existing mountains.

A period of considerable duration elapsed between the emission of the lava flows which displaced many of the rivers and the time at which the higher Sierra was covered by glaciers. In the interval most of the deep canyons of the range were cut out. Such, for example, are the Yosemite Valley on the Merced River, the great canyon of the Tuolumne, and the canyon of the Mokelumne. The erosion of these gorges was often facilitated by the fissure system referred to above, and many of the rivers of the range follow one or other set of parallel fissures for a long distance.

It is a question at what point the limit between the Neocene and Pleistocene should be drawn. It has become usual to regard the beginning of the glacial epoch in Eastern United States as the close of the Neocene. If it could be shown that the glaciation of the Sierra was coeval with that of northeastern America, a corresponding division would be adopted. It is believed, however, that glaciation was much later in California than in New England, and that the great andesitic flows mark the close of the Neocene.

The Sierra, from an elevation of about 5,000 feet upward, was long buried under ice. The ice did not to any noticeable extent erode the solid rock in the area which it covered, although it removed enormous amounts of loose material. It seems rather to have protected it from erosion while intensifying erosion at the lower elevations, just as would a lava cap. Small glaciers still exist in the Sierra.

IGNEOUS ROCKS.

Rocks of igneous origin form a considerable part of the Sierra Nevada. The most abundant igneous rock in the Sierra Nevada is granite, this term embracing both granodiorite and true granites. Rocks of the granitic series are believed to have consolidated under great pressure and to have been largely intruded into overlying formations at the time of great upheavals. Thus granite is a deep-seated rock, and is exposed only after great erosion has taken place.

The rocks called diabase and augite porphyrite on the gold belt maps are not always intrusive, but to some extent they represent surface lavas and correspond to modern basalt and augite andesites. In like manner, some of the hornblende porphyrites correspond to hornblende andesites.

GLOSSARY OF ROCK NAMES.

The sense in which the names applied to igneous rocks have been applied by geologists has varied and is likely to continue to vary. The sense in which the names are employed in this article is as follows:

Gabbro.—A granular intrusive rock consisting principally of diallage or allied monoclinic pyroxene, or a rhombic pyroxene, together with soda lime and lime feldspars.

Gabbro Diorite.—A term used to indicate areas of gabbro containing primary and secondary hornblende and areas containing intimate mixtures of gabbro and diorite.

Pyroxenite.—A granular intrusive rock comprised principally of pyroxene.

Peridotite.—A granular intrusive rock generally composed principally of olivine and pyroxene, frequently of olivine alone.

Diorite.—A granular intrusive rock consisting principally of soda lime feldspar and hornblende.

Serpentine.—A rock composed of the mineral serpentine, and often containing unaltered remains of feldspar, pyroxene, or olivine. Serpentine is frequently a decomposition product of rocks of the peridotite and pyroxenite series.

Granodiorite (quartz mica diorite).—A granular intrusive rock having the habitus of granite and carrying feldspar, quartz, biotite, and hornblende. The soda lime feldspars are usually considerably and to a variable extent in excess of the alkali feldspars. This granitic rock might be called quartz micadiorite, but this term, besides being awkward, does not sufficiently suggest its close relationship with granite; it has therefore been decided to name it "granodiorite."

Granite Porphyry.—A granite with large porphyritic potash feldspars.

Amphibolite, Amphibolite Schist.—A massive or schistose rock composed principally of green hornblende, with smaller amounts of quartz, feldspar, epidote and chlorite, and usually derived by dynamo-metamorphic processes from diabase and other basic igneous rocks.

Diabase.—An intrusive or effusive rock composed of augite and soda lime feldspar. The augite is often partly or wholly converted into green, fibrous hornblende or uralite.

Augite Porphyrite.—A more or less fine grained rock of the diabase series, with porphyritic crystals of augite and sometimes soda lime feldspars.

Hornblende Porphyrite.—An intrusive or effusive porphyritic rock consisting of soda lime feldspars and brown hornblende in a fine ground mass.

Quartz Porphyrite.—An intrusive or effusive porphyritic rock consisting of quartz and soda lime feldspar, together with a small amount of hornblende or biotite. It is connected by transitions with granodiorite and with the following:

Quartz Augite Porphyrite.—This is the same as the above except that it contains augite. It is connected by transitions with augite porphyrites and with quartz porphyrites.

Quartz Porphyry.—An intrusive or effusive porphyritic rock, which differs from quartz porphyrite in containing alkali feldspars in excess of soda lime feldspars.

Rhyolite.—An effusive rock of Tertiary or later age. The essential constituents are alkali feldspars and quartz, usually with a small amount of biotite or hornblende in a ground mass, often glassy.

Andesite.—An effusive porphyritic rock of Tertiary or later age. The essential constituents are soda lime feldspars and ferromagnesian silicates. The silica is usually above 56 per cent.

Basalt.—An effusive rock of Tertiary or later age, containing soda lime feldspars, much pyroxene, and usually olivine. The silica content is less than 56 per cent. It is also distinguished from andesite by its structure.

* The term "lavas" is here used to include not only such material as issued from volcanic vents in a nearly anhydrous condition and at a very high temperature, but also tuff flows and mud flows, and in short, all fluid or semi-fluid effusive volcanic products.

TABLE OF CONTENTS.